Compressed Air Magazine

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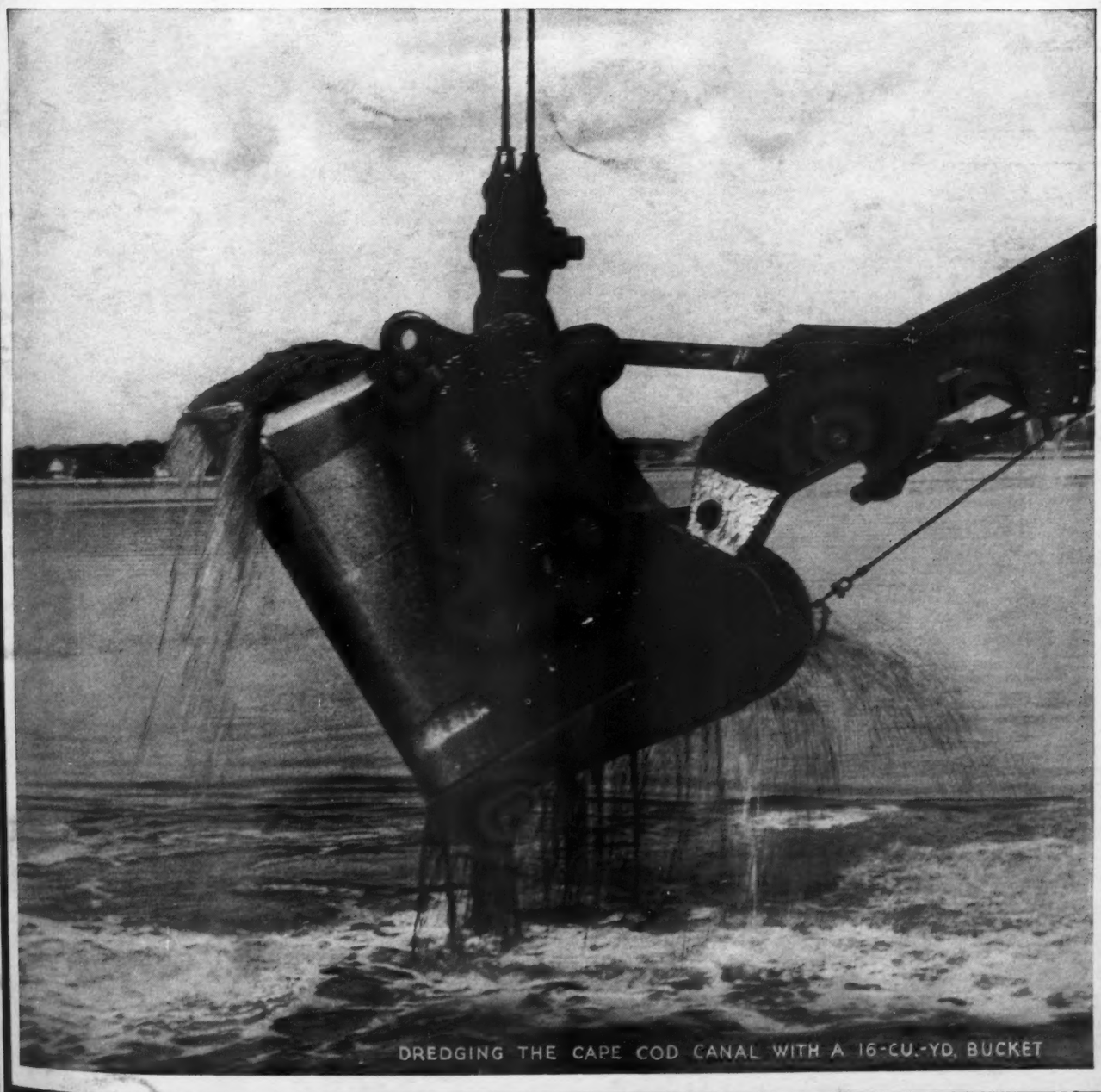

DREDGING THE CAPE COD CANAL WITH A 16-CU.-YD. BUCKET

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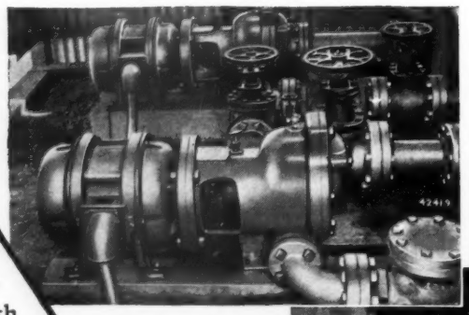
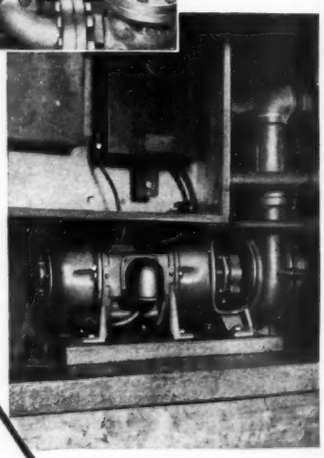
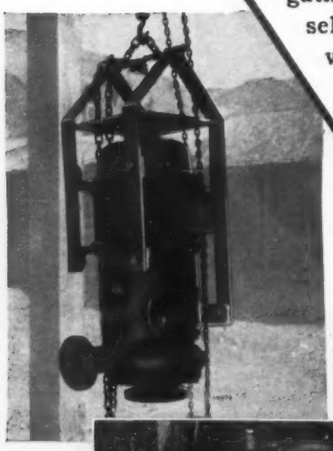


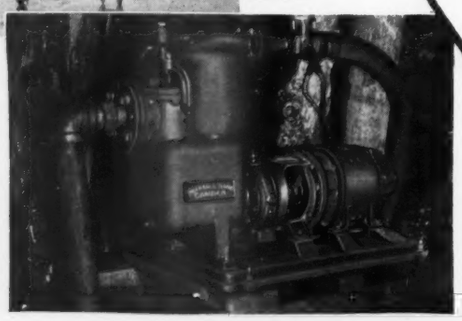
Two 2-stage units on a large construction job.



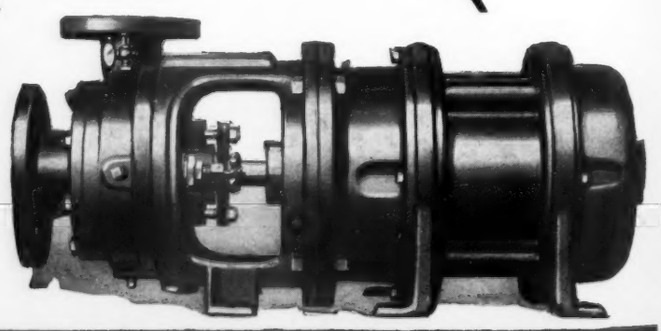
Motorpump used for dewatering a coffer dam.



Motorpump equipped with sling yoke for shaft sinking service.



Self-priming unit in a coal mine.



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Compressed Air Magazine

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JULY, 1936

Volume 41 — Number 7

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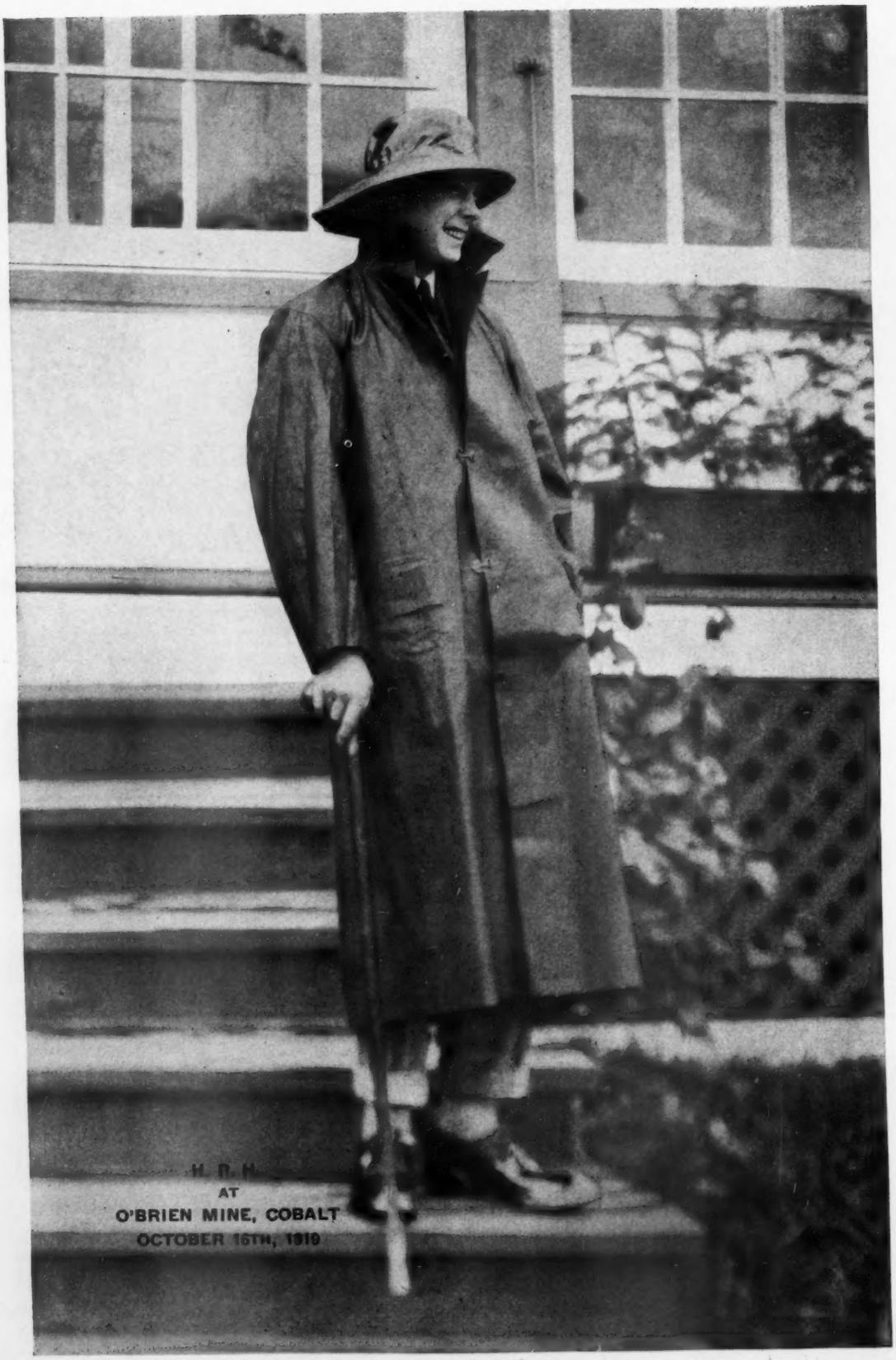
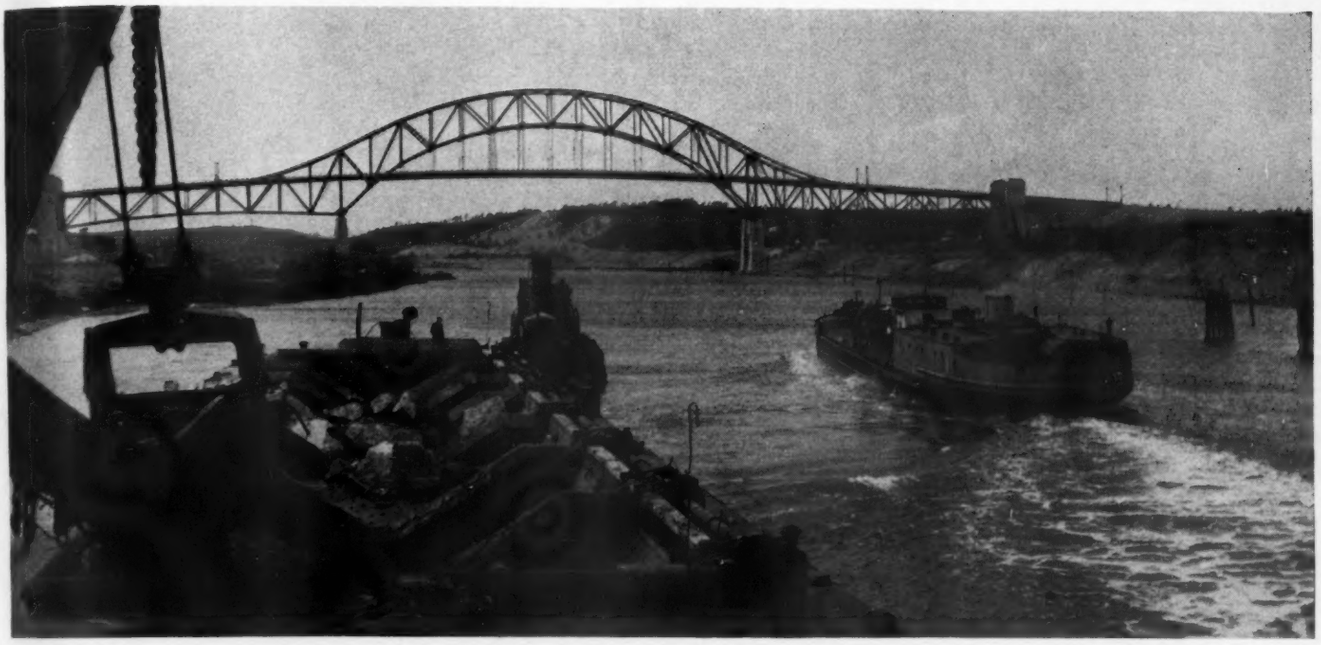


PROBABLY no monarch ever had a greater number of well-wishers upon ascending a throne than did His Majesty King Edward VIII of Great Britain. As the Prince of Wales, he was England's master envoy of good will and friendliness to the world at large. The informal photograph that is reproduced here was taken during one of his several visits to Canada.



DREDGING OPERATIONS

The 16-cubic-yard dipper dredge *Crest* loading a scow with the remains of one of the piers of the old Sagamore Bridge. Note that the work was conducted in a narrow channel without interfering with navigation. The new Sagamore Bridge is in the background.

An Unusual Drilling Job

Holes 60 Feet Deep Were Put Down During the Demolition of Old Bridge Piers in the Cape Cod Canal

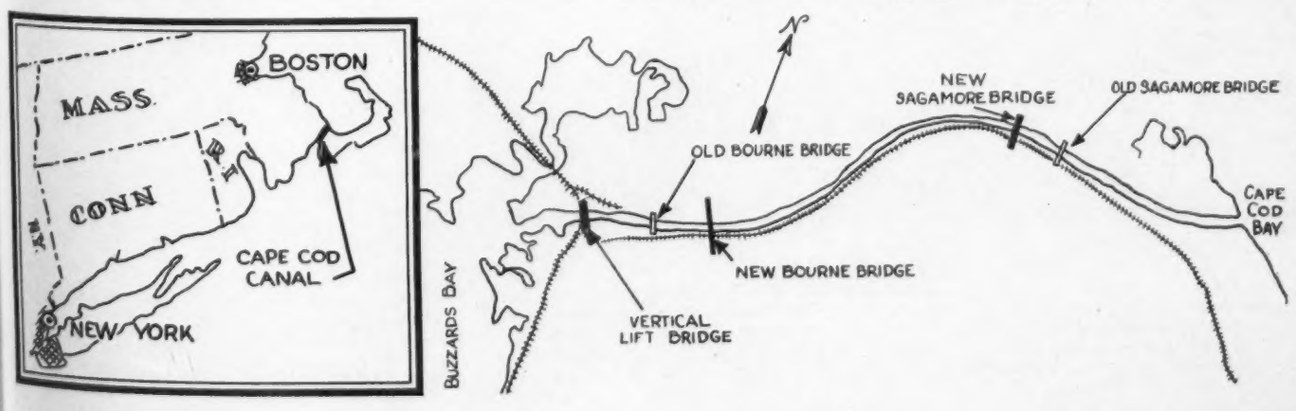
C. H. Vivian

BY ELIMINATING the treacherous journey around Cape Cod, the Cape Cod Canal provides a safe and short passageway for vessels plying between Boston and all points to the south. The waterway extends from Buzzards Bay to Cape Cod Bay, a distance of 7.7 miles, with extensions in the form of sea channels at either end that aggregate 5.3 miles. Its use has been limited to smaller craft, however, as it was constructed with a width of only 100 feet and a depth of but 25 feet. For all except tugboats and similar vessels it has been a 1-way canal. In order to make it of service to larger ships and thereby to multiply its usefulness, the United States Government is spending about $35,000,000 on a program of improvements. Upon its completion, the canal will have a bottom width of 540 feet and the water depth will be 32 feet. It now carries annually a little less than 3,000,000 tons of freight. In its enlarged state it will, it is believed, transport more than three times as much, or around 10,000,000 tons.

Although the cutting of a channel through the slender neck of Cape Cod was proposed by Gen. George Washington in 1776 as a means of giving Colonial ships greater security from the enemy, nearly 140 years

LOCATION MAP

The positions of the old bridges that have been removed and of the new ones that replace them are shown below. Cape Cod Canal is only about 8 miles long, but it saves 65 miles on the sea trip between Boston and New York. After the improvements now underway are completed, the waterway will be available for vessels of 30-foot draft.



passed before it was actually accomplished. In the interim, innumerable investigations were made and various charters granted to private companies, but nothing came of these efforts. Eventually, construction was started under a charter granted on June 1, 1899, to DeWitt C. Flanagan and others, who incorporated the Boston, Cape Cod & New York Canal Company. They completed their work in 1914, and the canal was formally accepted by the Commonwealth of Massachusetts in April, 1916. It was operated on a toll basis during the ensuing twelve years, with the exception of the World War period when the Government took it over. In 1928, the Government purchased the canal for $11,500,000, which was $1,500,000 less than the original construction cost. It was immediately made a toll-free waterway, and this greatly increased its use. Traffic has since shown a steady growth, and in 1933, the latest year for which reports have been published, 2,804,998 tons of cargo passed through it.

The economic importance of the canal lies in the fact that it provides a route between New York and Boston that is 65 miles shorter than the Long Island Sound-Cape Cod route and 166 miles shorter than the all-sea route by way of Nantucket lightship. Moreover, it is a much safer course and an easier one to navigate. Dense fogs prevail off Cape Cod an average of 1,000 hours a year, and the coastal waters are justly feared for their shifting shoals, deceptive currents, and seasonal gales. During the twenty years prior to 1920, more than 300 lives were lost and ships and cargoes worth $10,000,000 destroyed through the wrecking of nearly 1,000 vessels. In view of these facts it seems certain that extensive use will be made of the canal when it has been enlarged to accommodate bigger ships. In the past, vessels drawing more than 20 feet of water have generally taken the outside route, even though the theoretical depth of the canal has been 25 feet. The reasons for this are traceable to the tidal conditions that prevail in the region.

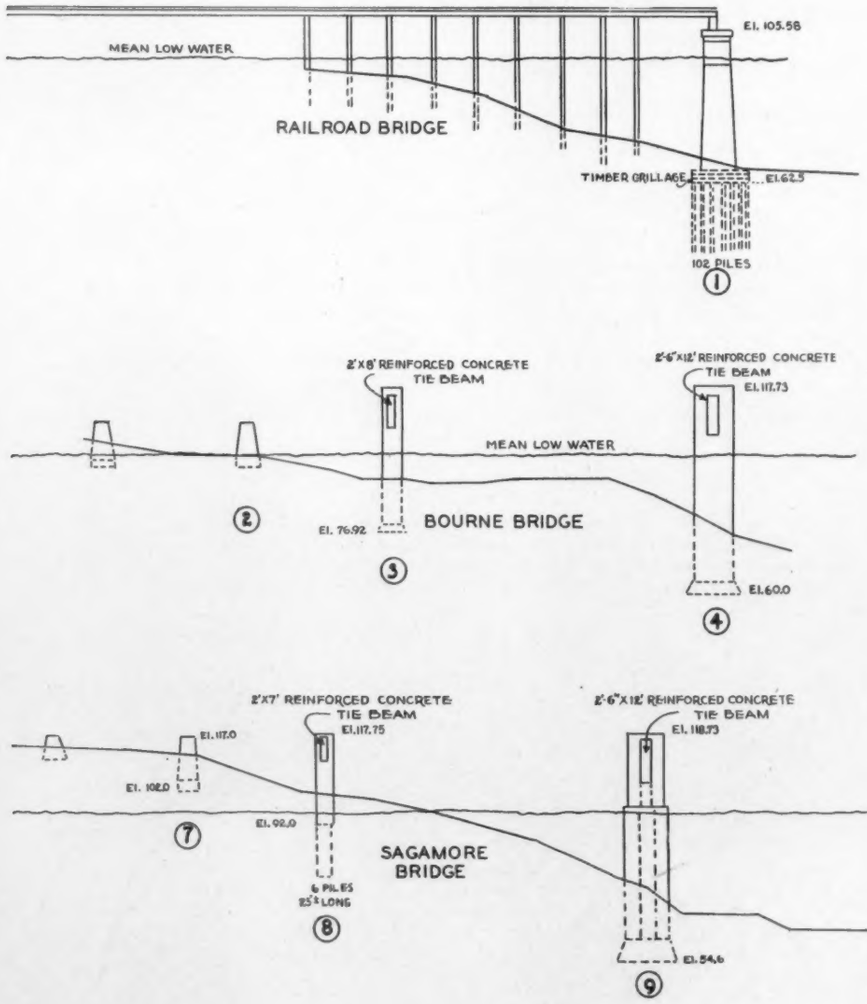
Although they are but a few miles apart, Buzzards Bay and Cape Cod Bay are so hemmed in by land that the tides do not reach them at the same time. In addition, there is a material difference in the tidal range in the two bays, that in Buzzards Bay being normally around 4 feet, as compared with an average of nearly 9 feet in Cape Cod Bay. This variation naturally results in a strong flow through the canal from east to west, the current sometimes having a velocity of 5 miles an hour. In a narrow channel such as the one under consideration, this causes larger craft serious navigation problems. Also, it erodes the banks of the canal and forms dangerous shoals. Persistent dredging operations by the Government have failed to maintain the depth at 25 feet, and masters of ships which have a draft close to that figure are loathe to attempt the passage.

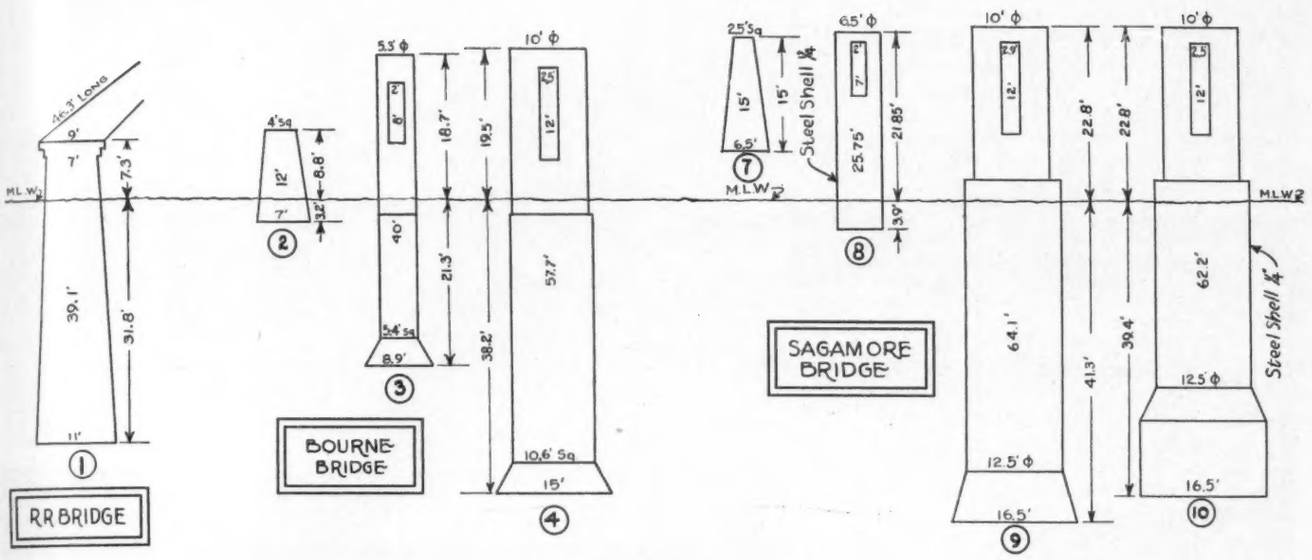
It has been suggested that the building of a lock at the Cape Cod Bay end of the waterway might eliminate the troublesome currents; but there are good and sufficient reasons why this plan is not acceptable. In the first place, the land which the canal traverses was deposited there by glaciers and consists of unconsolidated sand, gravel, and bowlders, some of the last named being as large as a good-sized house. Experience in making excavations in this glacial drift has shown that it would be difficult and very expensive to establish satisfactory footings for locks. In the second place, it is desirable to have moving water in the canal to keep it open for shipping during the winter. The blizzards that periodically visit the region sometimes produce ice as much as 18 inches thick, and if the water were still it is certain that the canal would be blocked many a year and for a considerable part of the year. Even with a strong current flowing, trouble from that source was encountered during the past winter, although most of the ice originated outside the canal and was carried into it.

The work now underway is in charge of the Engineer Corps of the U. S. Army. The first authorization of funds by Congress provided $23,500,000, but this was sub-

POSITIONS OF PIERS

The sketches below indicate the relative locations of the structures that were removed. All but one of these piers—No. 10 in the bottom drawing—were on the south side of the canal. The contour of the canal bottom is shown as it existed prior to dredging, which removed most of the earth from around the bases of the piers. All except the one in the railroad bridge consisted of two vertical members connected by a reinforced-concrete tie-piece. These uprights were variously of square or circular section. Details and dimensions of all piers are shown on the following page. Each is designated by the same number in the two drawings.





DETAILS OF PIERS

The railroad-bridge pier was a solid monolith of concrete, while the Bourne Bridge and the Sagamore Bridge piers were of the double type. Here are shown the structural details of all the piers that were removed, as well as the positions which they occupied with respect to the water line. Despite the fact that they had been in place for many years, the drill holes showed the interiors of all of them to be dry.

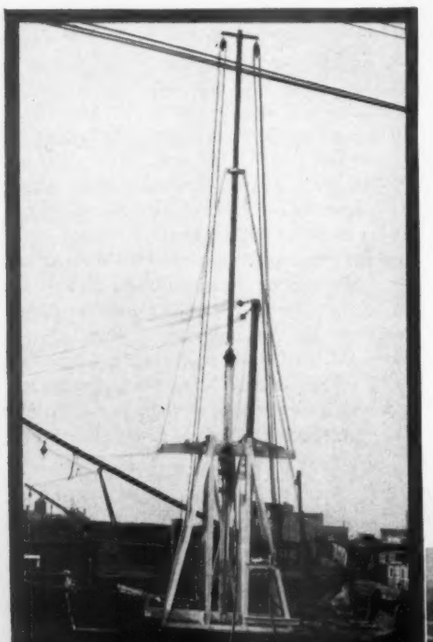
sequently increased to $35,000,000. The whole plan includes not only the enlargement of the canal proper but also the widening, deepening, and straightening of the approach channel in Buzzards Bay and the construction of mooring basins convenient to both ends of the land cut. As is customary on such projects, the work is being done under a series of contracts, and these will succeed one another until the undertaking is completed. The Great Lakes Dredge & Dock Company has been engaged for nearly three years on a contract calling for the widening of the canal from its original 100 feet to 205 feet, and it has also done considerable work on the western approach channel in Buzzards Bay. These activities have involved the movement of approximately 3,000,000 cubic yards of material.

Prior to the beginning of the improvements, the canal was spanned by three bridges, all of the bascule type. Two of these, the Sagamore Bridge, near the eastern end, and the Bourne Bridge, near the western end, linked highways. The third, at the extreme western end, was a railroad bridge and carried the single track of the New York, New Haven & Hartford Railroad which extends to Provincetown and other points on Cape Cod. All three were low-lift structures and had a clear width of only 140 feet between fenders, so that it became necessary, as a part of the canal-widening scheme, to replace them with new bridges. For this purpose a sum of $4,600,000 was allocated from the funds made available by Congress. The substitute structures have been completed, the two highway bridges having been formally dedicated last August as a feature of Old Home Week which was then being celebrated on Cape Cod. At the same time there was attached to the new Bourne Bridge a plaque designating it as the most beautiful bridge costing more than $1,000,000 constructed during 1934. The selection was made by the American Institute of Steel Construction.

The Bourne and Sagamore bridges are identical so far as their middle sections are concerned. They are of the continuous-truss type, and each has a main span, 616 feet long between points of support, and two side spans, one at each end and 396 feet long between supports. In addition, the Bourne Bridge has two approach spans at each end that range in length from 208 to 270 feet. The center spans have a minimum clearance above mean low water of 135 feet for a clear width of 500 feet. The vertical clearance is the same as that of the East River bridges in New York City and is ample for any ship that is likely to use the canal. As it was not practicable from a financial standpoint to give the railroad bridge a fixed span of such a high clearance, it was built with a lift span having a length of 550 feet between its supporting towers. It is said to be the largest span of its type ever constructed. When elevated to its full height it provides 135 feet of clearance. As train service is infrequent, it will normally be kept in its raised position to permit the free passage of shipping. Equipment is installed for lowering it in two minutes. The old low-level bridges not only interfered with the progress of vessels through the canal but, because they had to

RAILROAD BRIDGE PIER

This was a solid block of concrete 39.1 feet high, 46.3 feet long, and varying in thickness from 11 feet at the bottom to 9 feet at the top. Thirteen vertical holes were drilled in it, five in the center and four on each side. They are shown with cordeau attached ready for blasting. The drill rig that served as a mounting for the X-71 drifter drill with which the holes were put down is shown just behind the pier.



MISCELLANEOUS VIEWS

Weather conditions were extremely severe during the working period, as indicated in the top view, which shows a tug towing a workboat with a portable compressor on board through the ice floes. The picture immediately above was taken from beneath the new railroad lift bridge just as one of the old piers was being blasted. At the left is the drill rig on which the X-71 drifter drill was mounted for the deep-hole work. A 10-foot extension was placed on top of it for handling the 60-foot steel. Below is a stretch of the canal as it appeared in the course of the widening operations.

OLD BASCULE BRIDGE

This structure formerly carried the track of the Cape Cod branch of the New York, New Haven & Hartford Railroad and was one of the three bridges that were removed. It is shown in open position to permit the tug *Richards* to bring a light scow into position for loading by the dredge boat *Crest*. It has been replaced by a lift bridge having the largest lift span thus far built.

be opened often in the course of a day, they also materially slowed up road traffic, which averages 20,000 vehicles daily during the summer months and reached a peak of 40,000 on one day in 1932.

The two highway bridges were designed by Fay, Spofford & Thorndike, Boston consulting engineers, who engaged Cram & Ferguson of Boston as advisory architects. Contractors for their construction were the C. J. Carlin Company of New York, for the foundations, and the American Bridge Company for the superstructures. The railroad bridge was designed by Parsons, Klapp, Brinckerhoff & Douglass, New York consulting engineers, with McKim, Mead & White as architectural consultants. The Blakeslee Rollins Corporation of Boston was contractor for the foundations, and the Phoenix Bridge Company of Phoenixville, Pa., for the superstructure. All three were completed in well under two years.

Following the opening of the new bridges, the old structures were removed to enable canal widening to proceed at their respective sites. After the superstructures had been dismantled, there still remained the concrete piers, and the work of taking them out was contracted to the Great Lakes Dredge & Dock Company. As the widening thus far done has been confined to the south bank, only the piers on that side were removed, with the exception of one Sagamore Bridge pier on the north side.

There were eight of those piers: one in the railroad bridge, three in the Bourne Bridge, and four in the Sagamore Bridge. However, although each of the seven supporting structures in the highway bridges was classed as one pier, it actually consisted of two piers connected at the top by a transverse, reinforced-concrete tie-piece. These several uprights were of varying sizes and construction, details of them being shown in accompanying sketches. One of the twin piers in the Bourne Bridge was 40 feet high, and another was 57.7 feet high. These were exceeded by two similar piers in the Sagamore Bridge, one of which was 62.2 feet high and the other 64.1 feet high. The smaller piers tapered gradually, while the larger ones had straight sides, flaring only at their bases. However, in the case of each of the four members of the two tall twin piers of the Sagamore Bridge—which were, in fact, the highest in the entire group—there was a setback at a point about two-thirds up from the bottom, and there the thickness decreased from 12.5 feet to 10 feet. The railroad pier was a solid block of concrete 39.1 feet high, 46.3 feet long, and varying in thickness from 11 feet at the bottom to 9 feet at the top.

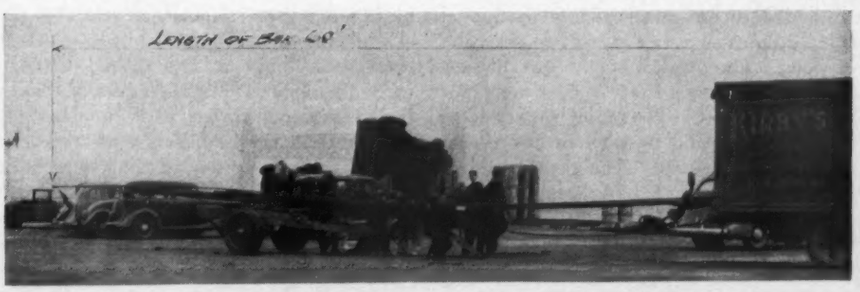
The general method of procedure decided upon was to drill and blast the piers and to recover the shattered material from the water by dredging. The chief problem was how to drill the higher members of the double piers of the highway bridges. The simplest scheme, and one which immediately presented itself, was to drill each pier down to a level near the water line—a distance of around 20 feet, and then to shoot this off and drill the remaining section from a new set-up. However, this would have required two dredgings, as the channel had to be kept clear for shipping. It would also have meant dividing the drilling and blasting into two operations and, consequently, doubling the associate work of handling equipment. From the contractor's standpoint this would have entailed additional time and expense; and a little while spent with pencil and paper showed that it would run the costs so high that money would be lost on the job. It was therefore determined to drill the piers from top to bottom in one step.

This decision meant that in the case of two of the double piers it would be necessary to drill to a depth of 60 feet, and in the case of a third one to a depth of 55 feet. Forty feet is generally considered the limit of effective drilling, and this is so commonly accepted that longer drill steel is not kept in stock. There was also the further complicating circumstance that standard drill mountings for the handling of steels more than 40 feet in length were not available.

At the outset it was planned to remove 5 feet from the tops of the higher piers, and thereby to limit the drilling depth to a maximum of 55 feet. On this basis, four sets of steels of 42-, 48-, and 55-foot lengths were ordered from a steel mill in Pittsburgh. These were made up specially and delivered at the canal. The plans were then amended and called for drilling the full 60 feet. As the work was about ready to start, a request for 60-foot steels was telephoned to the mill. It happened that only one 60-foot bar was available. This was sent by express to Quincy, Mass., where it was given the required shop treatment and thence dispatched the remaining 30 miles to the job by truck and trailer.

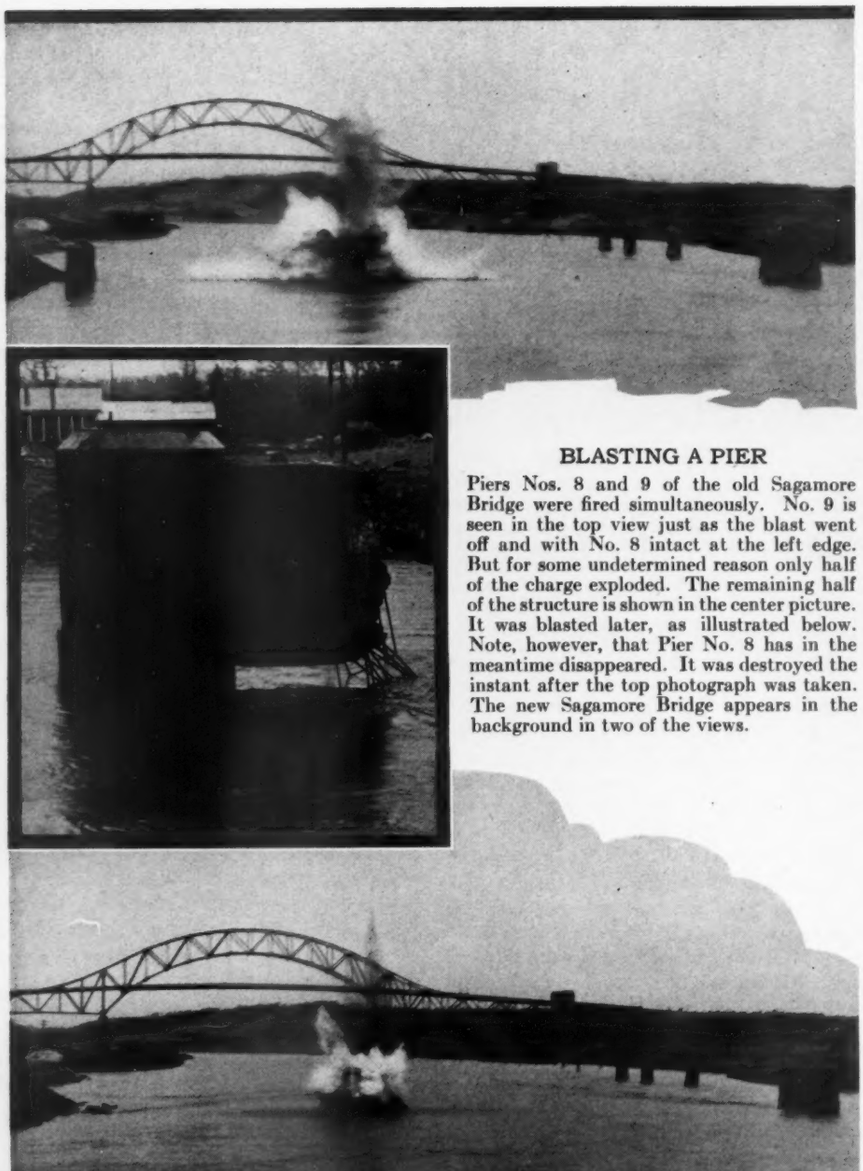
The steels employed were of hollow, round section, 1¼ inches in diameter. As it had been decided to use "Jackbits" for all the drilling, the steels were provided with threads so as to serve as drill rods. It is of interest to note that only three threads were broken on the entire job. The 60-foot steel drilled the holes expected of it without being damaged in any way.

All the drilling of the higher piers was done with an Ingersoll-Rand X-71 drifter



DELIVERING DRILL STEEL

The 60-foot bar of drill steel that was used on this job was shipped by express from Pittsburgh and then trucked 30 miles to the scene of operations. It is shown here just prior to unloading from the truck and trailer. The bucket of the dredge boat *Crest* is seen behind it, and in the distance is the shadowy outline of the new vertical-lift railroad bridge.



BLASTING A PIER

Piers Nos. 8 and 9 of the old Sagamore Bridge were fired simultaneously. No. 9 is seen in the top view just as the blast went off and with No. 8 intact at the left edge. But for some undetermined reason only half of the charge exploded. The remaining half of the structure is shown in the center picture. It was blasted later, as illustrated below. Note, however, that Pier No. 8 has in the meantime disappeared. It was destroyed the instant after the top photograph was taken. The new Sagamore Bridge appears in the background in two of the views.

drill. In view of the fact that there was no standard mounting for the handling of the long steels, one was built in the Staten Island, New York, yards of the Great Lakes Dredge & Dock Company. It consisted of a base made up of angle irons and channel irons, ⅜ inch in section, and of an extension of wood. The over-all height was 30 feet. After the apparatus was on the job, a further wooden extension 10 feet long was added to it so that it could be used in connection with the longest steels. The metal base was made to be assembled by bolts, and was shipped to the scene of operations knocked down. Steels were handled in this tower by means of a "Little Tugger" air hoist that was mounted on the metal base. The drill rig was moved about as needed and spotted for work atop the various piers by a derrick aboard the drill scow *VP 2*.

One of the surprising features of the work was that only one drill hole was required for shattering each upright member of the double piers, notwithstanding the fact that the bases of the four larger ones were 16.5 feet square. This single hole was started exactly in the center of the top of each pier and was carried downward without any trouble of a serious nature developing. In one instance a steel plate ⅝ inch thick was encountered, but it was drilled through without difficulty. In the cases of two of the Sagamore Bridge piers it was discovered that they had been reinforced with six lengths of 4-inch pipe that were filled with concrete. Five of these were spaced around the outside edge, but the sixth was in the middle. These pipes did not extend to the surface, and their presence was not known. It so happened, however, that the hole was spotted right over the center pipe in each instance and drilled inside of it for its full length. This inclosure of the hole had no appreciable effect upon the action of the explosive. All holes were started with 3½-inch bits, and in the case of the 60-foot drill holes they were bottomed with 2⅛-inch bits. Drill rods were changed every 6 feet of penetration.

The holes were loaded solidly to within 3 feet of their tops with 40 per cent gelatine dynamite and 50 per cent straight dynamite. In the lower, smaller-diameter parts of the holes were placed 1¼x8-inch cartridges, while those used in the upper portions were 2x8 inches. Where the piers were double, the cross piece was drilled at several points with an S-68 "Jackhamer" and the holes were loaded with dynamite in cartridges. All the holes in the twin piers were fired simultaneously with cordeau.

The charges of explosives were calculated in each instance to shatter the concrete but not to scatter it widely. The effect of the blast was to disrupt the mass and to leave the fragments in a confined area. As it was necessary to remove the material immediately so as not to delay shipping, the dredge boat *Crest* was kept ready at hand and at once began loading it into scows. The *Crest* is equipped with a 16-cubic-yard dipper, which enabled it to perform its allotted task with dispatch. In no case was the interval between the time of blasting and the depositing of the broken concrete out at sea longer than twelve hours; and the work was timed so that there was no interference with navigation through the canal.

The large railroad pier had a concrete island at the top, and this was smaller in breadth and in length than the body of the column. In breaking up this pier five holes were drilled in that surmounting section and eight holes in the main mass, four on each side. The shorter piers were drilled with an S-68 "Jackhamer," one hole being placed in the center of each column, as in the case of those drilled with the more powerful drifter drill. In one of the twin piers of the Sagamore Bridge, holes 22 feet deep were successfully put down with the hand-held drill.

Viewed from any angle, this job of demolition constituted an outstanding piece of drilling. It attains even greater significance, however, by virtue of the fact that it was carried on last winter during the most adverse weather conditions imaginable. It was started on December 28 and finished on March 11. Drill runners were perched atop the piers without any protection from the biting wind, and the subzero temperature severely tested men and equipment alike. Despite the fact that the canal is normally free from ice, heavy floes filled it for more than a week.

The Cape Cod Canal improvement work is being done under the direction of the U. S. Engineer office at Boston. Col. John J. Kingman is district engineer and H. N. Crichton is principal engineer. The phase of the project just described was done under the direction of A. H. Downs, superintendent of the Atlantic Division of the Great Lakes Dredge & Dock Company. Capt. Joe Burns served as field superintendent.

THE "PHILADELPHIA" TODAY

The gondola, refloated and towed to a dock at Burlington, Vt. The rails in the bow constituted a slide for the 12-pound cannon. Along the starboard rail (left) is visible a shot rack with depressions in which the cannon balls rested within convenient reach.

DIVER LILJA

Mr. Lilja has just come up from an inspection of the wreck and is explaining its condition to his coworkers.

Another Revolutionary War Vessel Recovered

"Philadelphia" of Benedict Arnold's Flotilla Raised from Lake Champlain

R. G. Skerrett

WHAT is probably the best preserved of the fighting craft that helped us to win our national independence was recently salvaged after a submergence of substantially 159 years. We refer to the gondola *Philadelphia* which went to the bottom of Lake Champlain on October 11, 1776, when Brig. Gen. Benedict Arnold contested the advance of Gen. Sir Guy Carleton's fleet, then moving southward to effect a juncture with another British force at Albany, N. Y. The refloating of the long-lost *Philadelphia* has made it possible to answer a number of questions that have puzzled writers on American naval history for generations.

Statistical data about our early armed vessels tell us in general terms the number and the different classes of craft that Benedict Arnold had under his command on Lake Champlain. We know how many men each vessel carried; and from the same source we learn of the number and the caliber of the guns that formed the batteries of those fighting units. But there has been little if any information available concerning the structural features and the dimensions of the boats that then joined battle with Carleton's fleet. At last, we have visible and positive evidence of the form, size, and military characteristics of the eight gondolas that constituted an important part of Arnold's flotilla. The term gondola has thus ceased to be enveloped in mystery and a subject for unconvincing speculation. The recovered *Philadelphia* is of twofold value—she supplies us with detailed particulars that were unavailable until she was salvaged last summer, and she is splendid proof of just what our people were able to do under pressure and when laboring at a great disadvantage.

In the January, 1935, issue of COMPRESSED AIR MAGAZINE was told the story of the recovery of the wreck of the *Royal Savage*, the schooner that was Arnold's flagship at the battle off Valcour Island. It will be recalled that that historic relic consisted only of the backbone and ribs of the original craft—hostile gunfire, flames, souvenir hunters, and the ravages of time having variously despoiled her. Even so, her waterworn timbers are treasured because of their association; and a contemporaneous drawing, still extant, gives us a good idea of what the schooner was in her fighting prime. She was the product of qualified British shipwrights, and was captured at St. Johns on the Richelieu River when Gen. Richard Montgomery moved on to Quebec in 1775. To retaliate for that attack, General Carleton assembled the year following a formidable combined naval and military force to sweep southward from St. Johns with the aim of splitting the colonies in twain.

General Carleton was able to draw upon the shipyards of Great Britain to build the most powerful of his ships; he was able to man them with trained seamen and marine

THE SALVORS

From left to right: J. Ruppert Schalk, William Lilja, and L. F. Hagglund. At the lower left the top of the lowermast of the *Philadelphia* is emerging from the water. Nailed to it is a replica of the Colonial flag that she flew during the battle in which she was sunk. The indications are that the lowermast, which stands fully 35 feet high, was surmounted by a topmast.

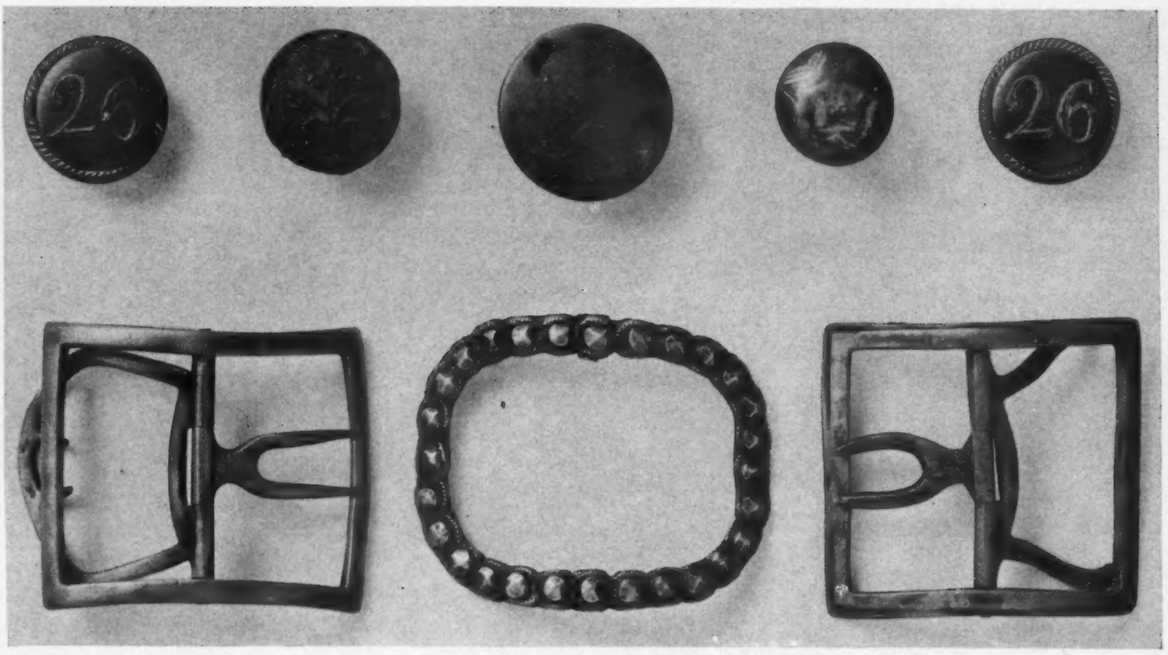
gunners; and circumstances made it comparatively easy for him to organize his expedition and to perfect its equipment in every particular. The American squadron, with the exception of the *Royal Savage*, the smaller schooner *Revenge*, and the sloop *Enterprise*, was the product of a shipyard called into being for the purpose at Skenesborough, at the southern end of Lake Champlain, where the neighboring forests could be counted upon to furnish the necessary timber. A handful of shipwrights was marched from the Atlantic seaboard to provide a nucleus of indispensable workers, and the remainder of the construction force was recruited from the farmers and militiamen in the nearby region. Success of any kind depended upon creating a flotilla with all possible dispatch by transforming standing timber into gondolas and galleys.

The desperate situation compelled tireless efforts and the turning out of types of craft that could be maneuvered either under canvas or with long oars or sweeps when a sufficient or a favorable wind was not blowing. Also, to add to their mobility both in attack and retreat, the vessels had to be of light draft to adapt them to the variable waters of Lake Champlain. The gondola *Philadelphia* exemplifies today what was achieved in that isolated shipyard when she and her seven sister ships, as well as five galleys, were built there under the stress of haste. The characteristics of the latter type are still uncertain because no drawings of them are available, nor has the hulk of any one of them been salvaged.

The *Philadelphia*, hulled several times at the water line by solid shot from the heaviest of the British cannon, sank after nightfall in the deep water of Valcour Bay, and her position remained unknown until early in August of last year. Then Capt. L. F. Hagglund, who had previously refloated the wreck of the *Royal Savage*, with the collaboration of J. Ruppert Schalk, engaged in sweeping operations to locate, if possible, whatever remained of the gondola. After a while the cable was brought up against what indicated a large obstruction on the bed of the lake at a depth of 60 feet. A diver identified it as an armed vessel and ascertained the size of the hull—the measurements corresponding with some of the assumed dimensions of the *Philadelphia* of Arnold's flotilla. Captain Hagglund, himself, then donned a diving suit and inspected the wreck inside and out; and his examination convinced him that they had, indeed, found the gondola. The next thing was to settle upon ways and means to break the hulk loose from the bottom without damaging it, to refloat it, and then to tow it to a sheltered area where it could be safely beached. The wreck lay a little less than a quarter of a mile offshore from the southern end of Valcour Island and at a point where the channel between the island and the western shore of Lake Champlain has a width of approximately 3,000 feet.

The main battery of the *Philadelphia* was known to have consisted of three sizable guns of that naval period, and three such guns were found aboard the submerged vessel. The immediate problem of the salvors was to lighten her by clearing away her armament and any other removable dead weight. The cannons were reclaimed with the aid of empty tar drums serving as submergible pontoons. These were filled with compressed air to provide the needful buoyancy to lift the old muzzle-loaders, one by one. When sufficiently stripped, the wreck was brought to the surface by a floating derrick that could exert a pull of 15 tons. But before this effort could be applied it was necessary to take certain precautions against damaging the aged and water-logged gondola when freeing her from the grip of the lake bottom. That is to say, the lifting pull had to be distributed so as not to overtax at a single point the keel or backbone of the craft. These preparations were made by an experienced marine diver, William Lilja.

First the diver, by means of a jet of high-pressure water, tunneled under the keel of the *Philadelphia* at three places at intervals of about 20 feet, and through those open-



RECOVERED RELICS

Buttons from the uniforms and buckles from the shoes of the *Philadelphia's* personnel, and pewter spoons that were used in her galley. The buttons with the numeral "26" were probably from a British uniform that had somehow come into the possession of the Colonials. Two of the spoons bear the crudely cut initials of their owners.

ings he passed hempen ropes to form enveloping slings which were carried up and secured to three spars laid across the vessel and held down against her rail at each side. The spars functioned as spreaders to keep the slings from drawing inward against the hull planking when a lifting pull was applied. The slings were extended upward by six cables and brought together at a single shackle that was linked by a length of chain to the hoisting tackle of the derrick. With the slings tautened by a slight pull only, the diver used the water jet to wash away the contact between the bottom of the wreck and the mud of the water bed; and when the hulk was thus freed, the hoisting engine was turned over slowly to minimize any stresses on the rising craft. The top of the *Philadelphia's* lowermast, which was still standing, rose above the surface of the lake at 2.30 o'clock on the afternoon of August 9. A replica of the Colonial flag carried at the time of the Battle of Lake Champlain was nailed to the mast, and the lifting operation resumed. When the vessel's rail was awash, there was a brief pause for silent prayer and the firing of three volleys in honor of the men that had fought and died on the ship upon that fateful October 11, 1776.

Suspended from the floating derrick, the *Philadelphia*, together with the lighter, was transferred slowly to shallow water near Valcour Island. Then the gondola was lowered gently to the water bed where she could be thoroughly examined, have her shot holes patched, be pumped out, and made ready for towing to Burlington, Vt. It is deserving of mention at this point that the owners of the lighter that made the vessel's recovery possible, as well as the company that furnished the tugboat that moved her to Burlington, charged only a nominal fee because of their patriotic interest in the undertaking. At the present time the *Philadelphia* is high on the shore and housed so as to protect her from the vandalism of relic hunters. Plans are afoot, however, to construct an architecturally fine abiding place for her.

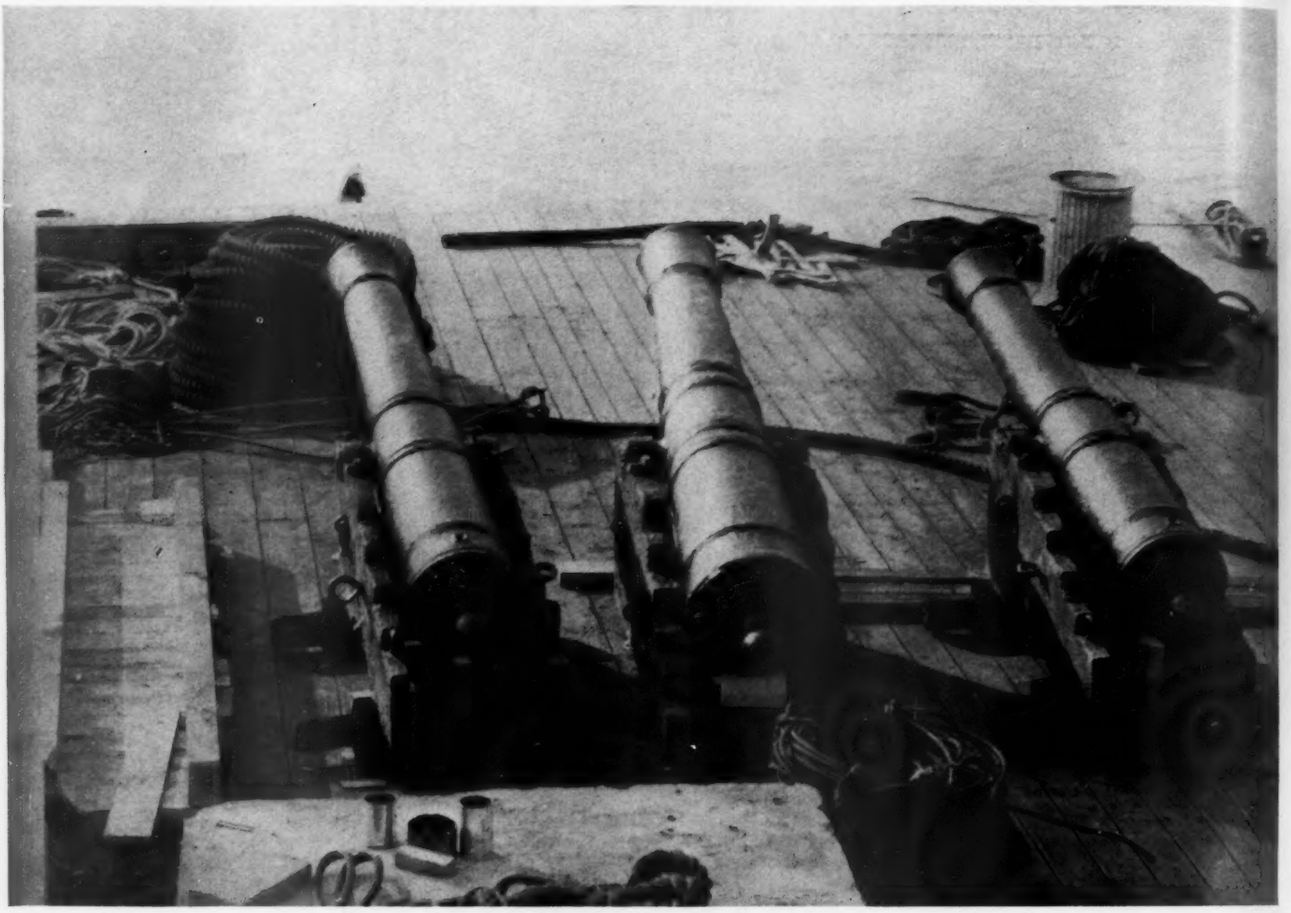
Although undoubtedly made of timber cut shortly before her building from the forests adjacent to Skenesborough, the *Philadelphia's* wooden structure is astonishingly well preserved despite the fact that most of her iron fittings were much corroded by their long submergence. It is relatively easy to visualize how the craft appeared when she measured forces with the British fleet, but we cannot so readily picture how her complement of 45 men was quartered in what was little better than a large open boat—there was no 'tween-deck space for their housing in inclement weather.

The gondola has a water-line length of 54 feet, a maximum beam of 15 feet, and a depth of but 5 feet between her rail and her bottom. Forward there is a shallow platform or deck on which her bow gun was mounted; a less expansive deck at the stern served for navigational purposes; and amidships, abaft the single mast, a lower deck afforded a platform for the working of her two broadside guns. The bow gun was a 12-pounder, and the broadside guns were 8-pounders—all of cast iron. The former, when being maneuvered for loading and firing, slid between wooden rails secured to the deck, while the 8-pounders were mounted on trucks that have disappeared, although their carriages still retain their axles.

When the *Philadelphia* was raised, a bar shot, designed for slashing an enemy's rigging, was found still projecting from the muzzle of the bow gun. The two midship guns were lying on their sides, close together, and their position has been interpreted in two ways: namely, that they were knocked over by hostile shot, or that they were lashed with slings to hoist them aboard another vessel—an operation that was prevented by her rapid sinking.

The gondola was planked outside and inside of her ribs; and both courses were pierced through and through below the water line in three places, which may well explain why she went to the bottom; and a cannon ball that was discovered between the inner and outer planking had made a hole in one course which would have helped to sink her. The *Philadelphia* is supposed to have carried eight swivels—light guns mounted in sockets along each rail and capable of being trained over a wide arc to repel armed boats or to sweep the decks of a foe at close range. No such guns were found on the wreck, although parts of a swivel mounting were salvaged. The assumption is that the guns, being readily removable, were carried off by the survivors when they abandoned ship just before the gondola foundered.

When refloated, the *Philadelphia* contained a goodly accumulation of silt; and after that blanket was cleared away the salvors recovered numerous interesting



MAIN BATTERY

The guns of the gondola are shown just as they were reclaimed after their submergence of 159 years. The center gun is a 12-pounder that was mounted at the bow, while the flanking 8-pounders did the broadside firing.

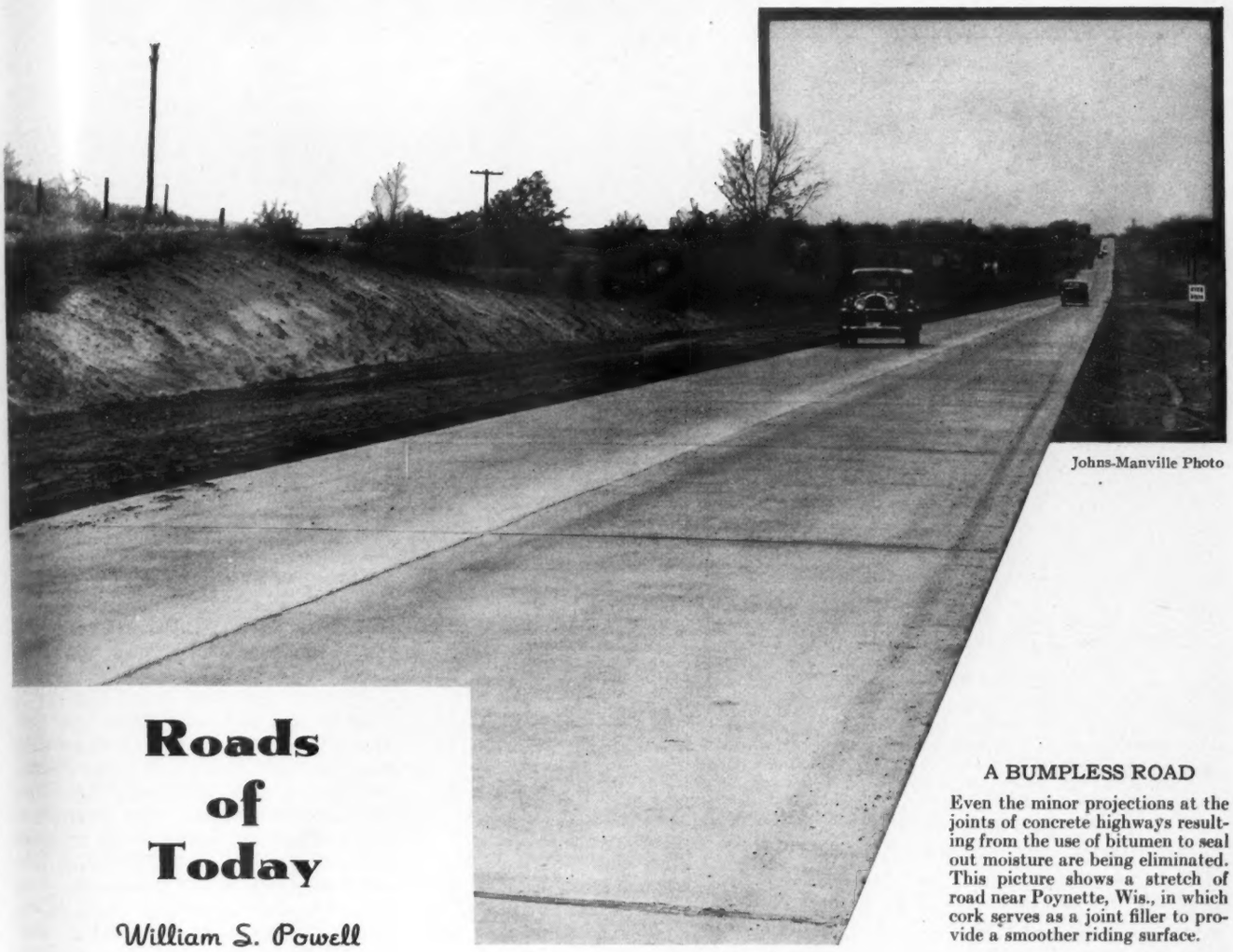
metal relics that bear evidence of the military make-up of the personnel and of their trappings. Some of the uniform buttons indicate that certain of the Americans were wearing captured British garments. Shoe buckles found in the mud were probably the adornments of the officers aboard; while the pewter spoons are all that remain of the mess kits with which the men were equipped. Some of these Colonial relics would be prized by antiquarians, for it is well known that Paul Revere made many of the pewter spoons used by the American fighting forces during the Revolutionary War. Parts of an hourglass were reclaimed, and may have served in navigating the vessel in logging the distance run when fog obscured the shore line.

The lowermast stands fully 35 feet high; and, while superficially waterworn, was undisturbed by its long submergence. The ship's running and standing rigging must have disappeared generations ago, but the remaining metal fittings and the upper end of the surviving spar make it certain that the *Philadelphia* had a surmounting topmast and boasted a sloop's goodly spread of canvas. With her sails and her sweeps she enjoyed considerable mobility and facility of maneuvering. Her guns, unfortunately, had not the range of those carried by the enemy craft that sent her to the bottom, nor had her gunners the experience of those that manned the British fleet.

It is a matter of history that the vessels of Arnold's squadron were screened along their bulwarks with boughs cut from the trees on Valcour Island to shelter the Americans from observation by foemen that might fire upon them from the timbered cover of the nearby shore. This was especially necessary in the case of the gondolas that lay low in the water and were open from bow to stern. It is conceivable that canvas or tarpaulin awnings were spread fore and aft and from side to side when the ships were at anchor so as to provide a measure of cover; but when underway these had to be removed so as not to interfere with the trimming of the sails.

The broad wind-swept waters of Lake Champlain can be very uncomfortable in the fall of the year, and the air then becomes keen and decidedly penetrating. The soldiers that manned Arnold's squadron were not sailormen nor used to conditions afloat; and viewing the *Philadelphia*, as she appears today, we cannot help but wonder how those patriots of 1776 solved the problem of living aboard those gondolas, and how they kept themselves reasonably fit for the grim task that was certainly ahead of them. It was, indeed, appropriate that those who witnessed the emergence of the gallant old craft should pause for a moment's prayer and the firing of a salute to the men that had courageously contested the southward sweep of a no less brave but far better equipped foe.

The wreck of the *Philadelphia* would probably still be undiscovered and on the bottom of Lake Champlain but for the united efforts of Captain Hagglund and Mr. Schalk, who, without thought of material gain, contributed of their resources and, in the case of the former, of his experience in marine salvage in locating and in reclaiming one of the vessels that helped to give Sir Guy Carleton a very wholesome respect for the Colonial forces standing between him and his projected goal. That opposition on the part of the Americans halted the British advance and gave the Continental commanders time in which to organize their resistance, which was crowned with conclusive victory the year following.



Johns-Manville Photo

Roads of Today

William S. Powell

A BUMPLESS ROAD

Even the minor projections at the joints of concrete highways resulting from the use of bitumen to seal out moisture are being eliminated. This picture shows a stretch of road near Poynette, Wis., in which cork serves as a joint filler to provide a smoother riding surface.

UNTIL the middle of the eighteenth century the roads of England were in an incredibly bad state. After 1750 there was slight improvement. In his *History of England*, Macaulay tells at great length of the need of highway repairs and improvements. Before 1700 Daniel Defoe wrote, "Supposing one takes the North Road to St. Albans; after Dunstable, the road disappears into deep clay, surprisingly soft, perfectly frightful." Another writer described the road from London to Bath as being "what God left it after the flood." Still another stated that the roadways were in such a deplorable condition that it was impossible to drive the cattle and beasts to market, and facetiously remarked that the men and women of Sussex "were long legged from the constant effort of pulling their feet out of the mud." So bad were the London streets that goods had to be transported on the backs of porters. In those days, travelers continually ran the risk of being attacked by bandits and robbers. As early as 1285, however, laws had been enacted which prescribed that shrubs and other growth for 200 feet on each side of highways be cut down so that possible assailants would have no place in which to hide.

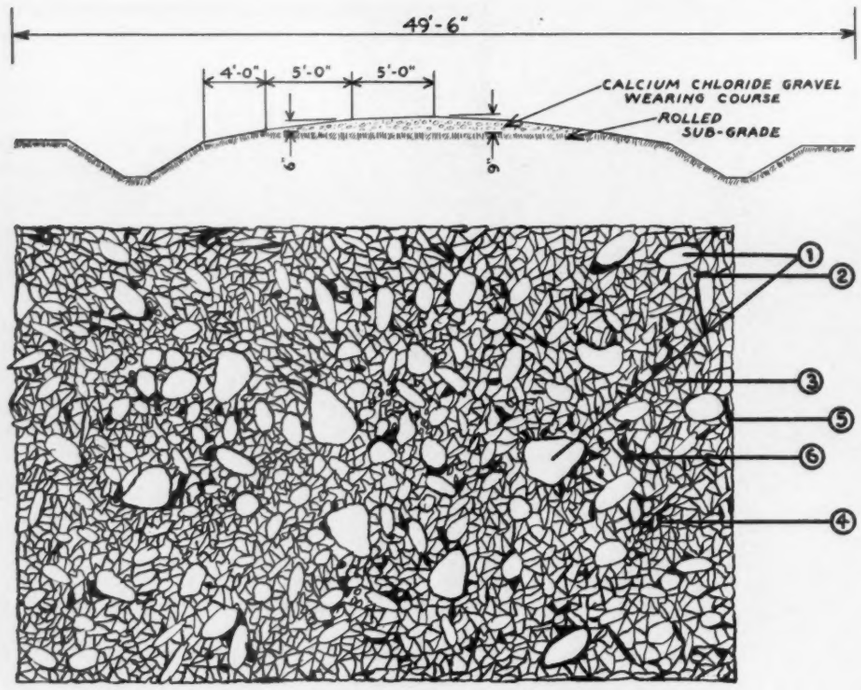
Acts of Parliament, providing for the improvement and maintenance of roads, tended to remedy the situation. The establishment of turnpike trusts and the collection of tolls were also helpful. Before that time, it was supposedly the duty of the various parishes to take care of the highways, but they oftentimes sadly neglected them.

The beginning of what might be called the modern era in roadbuilding is intimately associated with a Frenchman, by the name of Tresguet, and with two Englishmen, John L. McAdam and Thomas Telford. Tresguet, in 1754, conceived a road which consisted of a base of very large stones and a top course of smaller ones, both layers being compactly rolled. McAdam and Telford were the first to approach the subject of road construction from a scientific standpoint, and they conducted systematic and detailed studies to guide them in their work. That period was marked by a great expansion in civil engineering—by the building of harbors, canals, roads, and bridges on a large scale.

McAdam was born in Scotland, and developed what is known today as the macadam road. He was particularly interested in the subsoil, and believed that if it were made dry and kept dry the year round it would support almost any weight. Many of his principles and methods are still being followed by the highway builder.

McAdam always did much experimental work as a preliminary to actual construction. From 1798 to 1814 he traveled over 30,000 miles of English roads, inspecting them and making field tests. This took a total of 2,000 days and cost him about 5,000 pounds. It led him to the conclusion that the roadbed should be of broken stone, with suitable drains on both sides, and that it should be covered with a series of hard stones broken into angular fragments as nearly as possible of cubical shape and of the same size, and none more than 6 ounces in weight. He was of the opinion that the layers of stone would be gradually consolidated by the traffic and that the covering would thus become firm and solid, nearly impervious to water, and durable, depending, of course, upon the stone employed. Granite and greenstone were thought to be the most satisfactory for the purpose.

Telford was instrumental in giving England and Scotland better roads. It was through his influence that 920 miles of improved highways and 120 bridges were



SECTIONS OF STABILIZED GRAVEL ROADS

Extensive experiments are being conducted in an effort to stabilize soils which of themselves will not withstand traffic without deformation. Besides mixing coarse and fine materials in suitable proportions, a chemical reagent such as calcium chloride or common salt is often added to insure the retention of sufficient moisture to maintain stability. The upper sketch shows how such a road is built. Below it is a cross section of a small area, illustrating the distribution of the materials used. The figures indicate: 1, coarse aggregate; 2, coarse sand; 3, fine sand; 4, silt; 5, clay; 6, calcium chloride.

built in both those countries. He invented what came to be known as the "Telford base," which consisted of stones ranging from 8 to 15 inches in length, from 2 to 8 inches in width, and from 1 to 6 inches in thickness set on edge on the subgrade one against the other and crosswise in relation to the traffic. The placing of the stones was done by hand, and the chinks were filled with spalls, gravel, etc., so as to assure stability under rolling and traffic. Probably his most outstanding achievement was the construction of the suspension bridge across Menai Straits in North Wales.

With the expansion and betterment of highways, and incidentally transportation, trade improved greatly. Stagecoach lines were established and went in all directions, and roadside inns sprang up at numerous points so as to accommodate the travelers. Many of those hostelries are now historic landmarks and attract the sight-seeing public.

In present-day England, great attention is paid to roads, both with respect to construction and to maintenance. A department of scientific and industrial research has been created, and there is a laboratory at Harmondsworth, just outside of London, where all sorts of tests are made and much experimental work is done. Among its equipment is a circular runway over which a full-sized lorry or motor truck travels at various speeds for the purpose of testing different kinds of roads laid under normal conditions. It resembles a greyhound racetrack, with the exception that a 12-ton truck is substituted for the electric hare.

The trial track is said to be the largest of its kind in the world. It has a diameter of 110 feet, and the width of the roadway is 10 feet. The truck engine is replaced by a 180-hp., electric motor. The chassis is connected to a central post by a structural-steel arm along which are run the cables that supply power to the motor. When the truck is going at a maximum speed of 40 miles an hour, the centrifugal force is such as to exert a pull of 25 tons on the post, and engineers have calculated that if the vehicle were to break away it would have a momentum equivalent to that of a 6-inch projectile.

In order to prevent the wheels from running in the same place and causing ruts, transversing gear is provided and serves to move the connecting arm slowly backward and forward over the central post alternately to reduce and to increase the radius of the circle and thus to change the line of travel of the truck. Five minutes is required for a full traverse of the arm, and at maximum speed the truck covers the course in six seconds.

There are other novel testing machines in the laboratory. Among these is one for determining the skidproof properties of roads, and another, a motorcycle arrangement, that helps the investigator to find the sideways-force coefficient. Facilities are also provided for studying concrete-road slabs differing in composition and design, as well as bituminous mixtures and aggregates. Similar work is being carried on in other large countries.

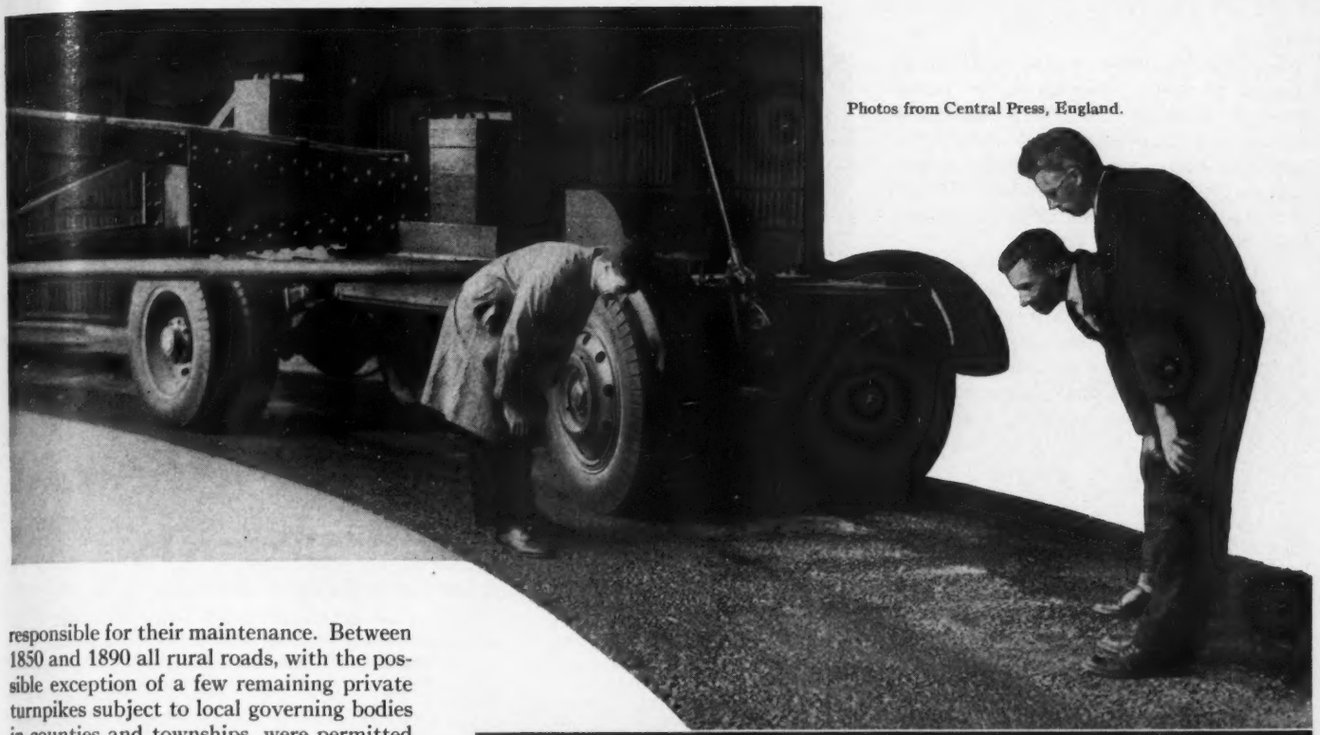
In the United States there were no roads to speak of and not much paving even of city streets until after the Civil War. In the days of the Indians there were only footpaths in America. As it was the practice of the redmen to walk single file, the paths were only about 18 inches wide and, naturally, became well worn. Following as they did the lines of least resistance, it was necessary for the early settlers only to widen them in order to make them meet their requirements. Today, some of those selfsame trails still exist in the form of fine, wide concrete highways.

The Mohawk Trail, between North Adams and Greenfield in Massachusetts is a notable example of such a road. It follows, for the most part, the original route which for many generations knew only the tread of moccasin-clad feet. For years before the coming of the white man it was a link in a system of well-defined Indian trails which reached almost without a break across the country.

Probably the first paved highway in America was that built in 1796 from Lancaster, Pa., to Philadelphia. It was 66 miles long, and was paved with stone overlain with gravel. The only road of importance which was constructed with Government funds in Colonial days was one extending 800 miles from Cumberland, Md., to Vandalia, Ill. It was 80 feet wide in places, with a macadamized strip of 30 feet, and was begun in 1806 and completed in 1840. Early migration to the West was served by this highway. It is now known as U. S. Route 40.

One of the roadbuilding pioneers in America was Claudius Crozet, chief engineer for the Commonwealth of Virginia. He first applied his skill to the construction of a highway from Staunton, Va., east of the Alleghenies, to Parkersburg, to the west on the Ohio River and in what is now the State of West Virginia. His preliminary survey was made "partly by triangulation from mountains and partly by chain and compass." His plan was to build the road about 30 feet wide, but because of the rugged nature of the terrain he was forced to narrow it to 12 feet. By 1847, there were several highways stretching westward. Traders from the East poured into the surrounding country in large numbers, and cattlemen and farmers journeyed to Richmond to market their products. Stagecoach lines were put in operation, and taverns catering to the travelers dotted the routes.

Just at the time when an active interest was being taken in highway construction the railroads came into prominence. This, naturally, proved to be a hindrance. The Federal Government then handed the supervision of the roads over to the states, which, in turn, made the various counties

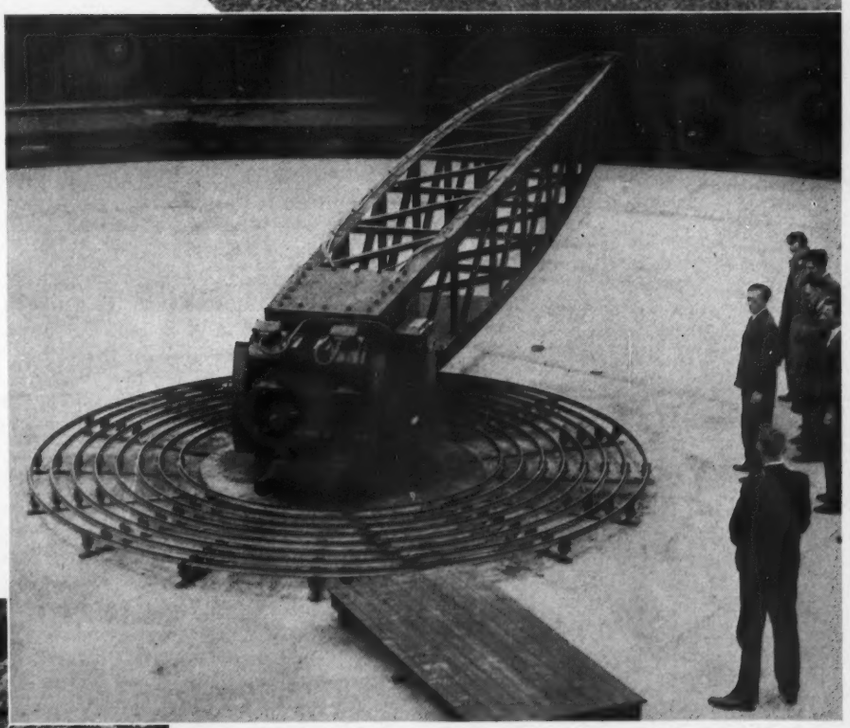


Photos from Central Press, England.

responsible for their maintenance. Between 1850 and 1890 all rural roads, with the possible exception of a few remaining private turnpikes subject to local governing bodies in counties and townships, were permitted to fall into a state of neglect.

New Jersey was the first to organize a highway department. That was done in 1891. Then followed Massachusetts, in 1892; Connecticut, in 1895; and New York, in 1898. Today there is a road commission of some sort in every state, and roadbuilding is considered a major industry. Before 1904, untreated-gravel, dirt, and macadam roads were most prevalent, and adequately served the horse-drawn traffic. However, with the appearance of the automobile and its increasing use, a need for better and more satisfactory highways made itself felt. Tar and asphalt were substituted for the weaker bindings of clay and water, and "pre-mix" was subsequently developed.

Originally, asphalt, tars, oils, and salt solutions were principally used as dust preventives, and were applied for the most part to old surfaces. Then tests were made



A ROAD-TESTING MACHINE

The pictures above show an ingenious device by which the effects of traffic on a road surface can be quickly determined. It is installed in the Road Research Laboratory at Harmondsworth, England, and consists of a 12-ton motor truck that is held on its circular, 110-foot-diameter track by means of a steel box girder extending from a central concrete post. Driven by an electric motor with power supplied by cables mounted on the mooring arm, it travels at speeds up to 40 miles an hour and requires no operator. By means of this machine, a sample stretch of roadway can be subjected in a few days to wear that it would take several years to acquire under ordinary circumstances.

The vast increase in highway building has led to the development of special machinery for the performance of almost every construction operation involved. Wherever rough country is to be traversed, rock drills and portable compressors are usually among the first equipment on the job. The view at the left shows the initial work on a road through the Sierra Nevada Range in California.

to ascertain the value of these materials as binders in newly constructed or reconstructed surfaces. Hot, dry aggregates coated with hot bituminous compounds and compactly rolled were tried successfully in 1908 and 1909. Between 1904 and 1914 the mileage of bituminous roads grew from 18 to 10,500.

During this period was also developed the penetration macadam surface. Engineers found that an adequate surface could be obtained by the employment of suitable crushed stone as a base and by applying hot bitumen under pressure. They also learned that water-bound macadam could be so treated if bitumen of the proper consistency were used. Various bituminous roadbuilding materials are now available; and natural rock asphalt, with which extensive experiments were made back in 1908, is today an important item in highway construction in areas where a supply of it is easily procurable. Experience has shown that it assures a satisfactory and durable road.

The greatest development in roadbuilding in the history of this country came after the World War. The public gradually became conscious of the economic importance of good roads; and in time a National Highway Association was formed with the view of fostering the growing sentiment and of securing the coöperation of the Federal Government in the establishment of a national highway system. Since then there has also been organized the American Roadbuilders' Association, which is very active.

From the standpoint of stability, wear resistance, and general serviceability, concrete is, of course, the most acceptable of the materials now available for highway construction. Paving blocks, vitrified bricks, and similar hard surfacings are preferable in certain sections where special conditions of soil or of topography have to be met. For the most part, however, they are extensively used only in cities, and concrete is usually selected for the heavily traveled main arteries. It assures a pavement that is second to none in endurance, and provides a smooth, easy-riding surface that adds to the comfort of motoring. When the subgrade is correctly prepared and given adequate drainage structures, concrete roads will resist the action of frost exceedingly well and will require but few repairs until they have been in service for a number of years. The growth in the number of automobiles and the advent of the heavy truck created a demand for heavy-duty roads and were the principal factors that led to the laying during the predepression era of thousands of miles of concrete highways.

ROADS OF FOUR ERAS

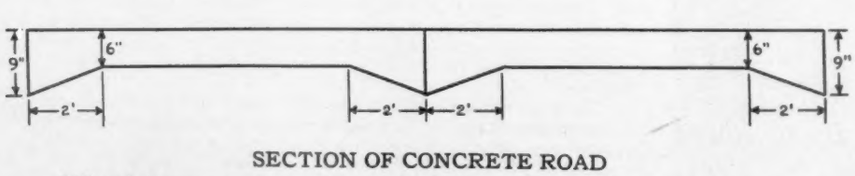
This year's spring housecleaning by the flood waters of the Delaware River removed all the soil from the outer shoulder of a half-mile stretch of U. S. Highway 611 a short distance below Easton, Pa., and revealed four types of highway construction. At the top is the present strip of concrete; just beneath it is a bituminous macadam surfacing; and next below is a water-bound macadam structure resting upon a Telford base. The stones of the latter, placed on edge, are plainly discernible. This is one of the sturdiest types of road base known, but is now little used because it must be placed by hand, and is, therefore, a slow and expensive operation. Below the Telford base is an old gravel highway that was probably the first road to be built there. This stretch of highway was scoured for 48 hours by a 7-mile-an-hour current that rose to within a few inches of the top of the wall in the background.

Because portland cement originated in the British Isles, it was first used there for roadbuilding. That was in 1865. Some of those old concrete pavements are to be found on Liven Terrace, Glengyle Terrace, and Gillespie Crescent in Edinburgh, Scotland, and they are still carrying traffic after 64 years of service. Thirty-six streets in Grenoble, France, were paved with concrete in 1876, and some of them still have their original surfacing. The first concrete pavement constructed in the United States is said to have been laid in Bellefontaine, Ohio, in 1892. It was a narrow strip on one side of the courthouse square and alongside a hitching rock for horses. The following year it was extended the full length of the square and the remaining three sides were similarly paved. All this concrete is still in place.

Many of our historic roads are now wholly or in part of concrete. Among these is the oldest commercial highway in the nation. It extends from Jimenez, Mexico, to Santa Fe, New Mexico. The latter city was founded and made the capital of New Spain by Don Juan de Oñate around 1606, and for many years freight consigned to it from Vera Cruz and Mexico City moved over that route. Today it is a part of the Santa Fe Trail and National Old Trails Road between Santa Fe and Socorro and is paved with concrete for 30 miles south of Bernalillo. The Green Bay Road, which was laid out along a trail connecting Fort Howard, now Green Bay, Wis., and Fort Dearborn, now Chicago, is concreted much of the way from Glencoe, Ill., to the Wisconsin line.

One of the country's famous old streets—Duke of Gloucester Street in Williamsburg, Va.— is now paved with concrete. It runs in a straight line for a mile, and connects William and Mary College with the site of the second House of Burgesses. Williamsburg, originally named Middle Plantation, was founded in 1632 and became the seat of government in 1698.

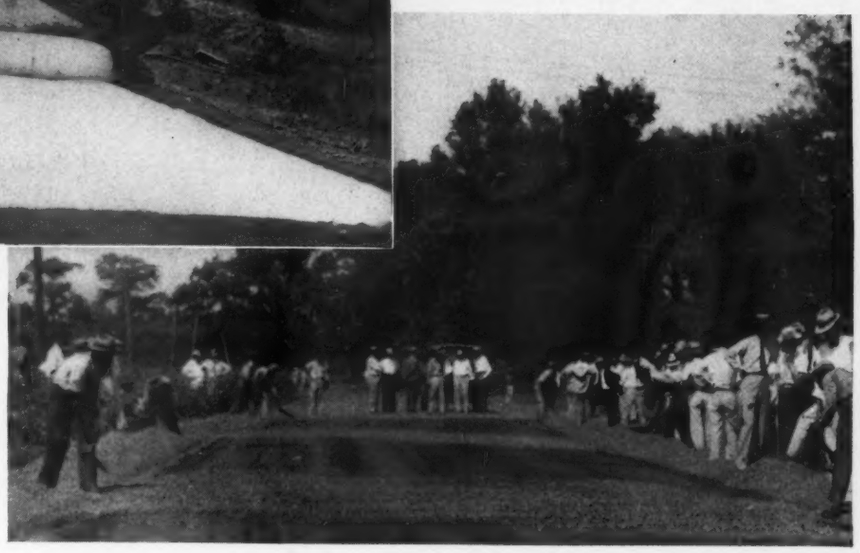
About the year 1806, Henry Clay lent his aid in the passage of an act that authorized the construction of a national toll-free road from the Potomac River to the Ohio River. The highway was later extended to the Mississippi, and soon became the principal avenue of travel to the West. It is now known as the National Pike, and is surfaced throughout its entire length from Washington to Kansas City, and much of it with concrete. More than a fifth of the 3,000 miles of the Lincoln Highway which spans the country from New York to San Francisco is concreted. In Indiana it includes a stretch of 40-foot pavement that



SECTION OF CONCRETE ROAD

Although concrete roads are of various types, those that are designed to carry heavy traffic are now usually constructed with steel reinforcing and are thicker throughout the sections that are subjected to the greatest loads.

Photos from Cotton Institute



COTTON IN ROADBUILDING

Cotton fabric is being extensively tested to determine its suitability as a reinforcing membrane for bituminous roads. After the base has been covered with bitumen, strips of cloth are laid on it, as shown in the upper picture. One or more additional coats of bitumen are then applied, after which gravel is scattered over the surface, (lower picture). The top dressing is then placed with the aid of mechanical equipment, the procedure being the same as that when no fabric binder is included.

has long been considered an outstanding example of concrete-road construction.

Another famous thoroughfare is the Coleman du Pont Highway that traces its way for 93 miles from near Wilmington, Del., to the Maryland line. It was over the northern part of it that Caesar Rodney made his celebrated horseback ride from Dover to Philadelphia on July 2, 1776, in order to cast Delaware's vote for the Declaration of Independence. Although confined to his home by illness, he made the trip when he learned that his state's two delegates to the convention had disagreed on how to vote. The road was paved with concrete at General du Pont's expense, and was formally presented to the state in 1924.

The first concrete highways consisted merely of slabs that were laid down without much attention to the subgrade and with little inspection of materials or control of the mixing process. They were relatively thin. By contrast, the building of such roads nowadays is a carefully regulated operation. Attention is paid to every detail, with rigorous inspection at all stages of construction. Highways are considerably wider than they were a few years ago; the slabs are thicker; and on routes where traffic is heavy it is customary to embed grids of steel bars for reinforcement and to increase the thickness at the edges of each traffic lane.

Cement-bound macadam roads are also successfully bearing present-day traffic. In building such a highway, a base of clean, sound, coarse aggregate, consisting of crushed stone, gravel, or slag, is laid on a prepared subgrade and bound together with a portland cement-sand grout of such consistency that it flows into and fills the voids. This method of construction was introduced in Scotland in 1872; but it was not employed in the United States until after 1900.

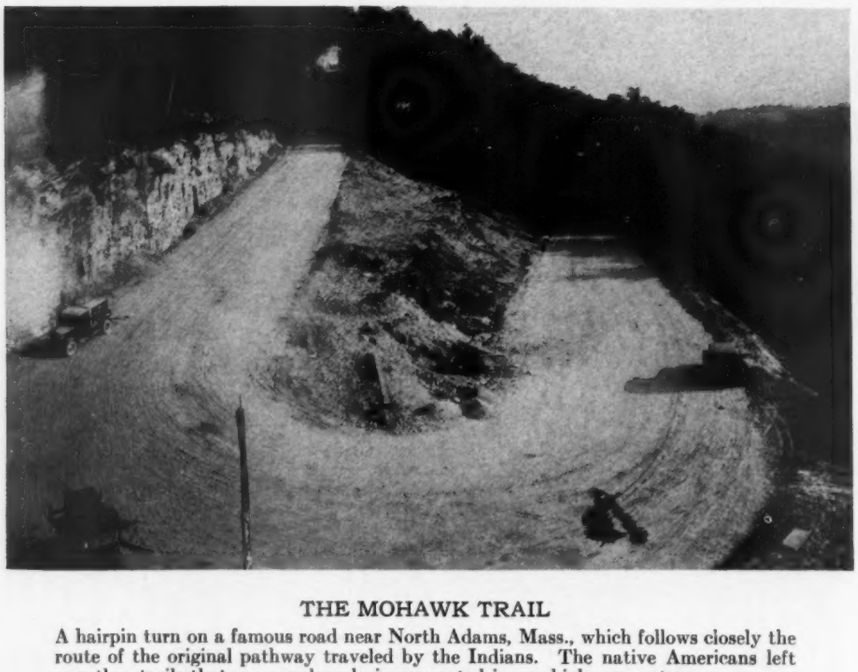
Although roadbuilding is in a highly developed state, it is still in a more or less experimental state. Research is the order of the day, and studies are being pursued continually in an effort to better existing methods and materials. One of the new lines of investigation has to do with the use of cotton as a roadbuilding material. Part of a recent Federal appropriation of $1,300,000 to promote a greater utilization of cotton is being allotted for highway experimentation. The Cotton Textile Institute is coöperating in this movement.

Thus far two ways of employing cotton have been devised: In the form of a fabric as a reinforcement for bitumen-surfaced roads, and in the form of mats for curing concrete slabs. In furtherance of the plan, the Government is offering the cotton material free of charge to state-highway commissions that will agree to use it as specified and to collect data on the results obtained. The scheme provides for the laying of 1,000 miles of reinforced bitumen-type roads and for the utilization of 80,000 curing mats for concrete structures.

The first known use of cotton fabric in this special field was made in 1926 in South Carolina, and most of the roads that have been put down since for the purpose of testing this material are in that state. It is placed in sheets, between the base and top course, and is said to provide an indestructible bond that lessens the chances of surface cracks and other failures resulting from extremes of weather or traffic.

It is intended, if possible, to bring about the building of cotton-reinforced roads in every state in the Union so that information may be secured as to their serviceability under all existing climatic conditions. New Jersey, which constructed its first highway of this type near Cranbury in 1934, will build 50 more miles. Michigan is planning 34 miles; Indiana, 20 to 25 miles; North Carolina and Alabama, 100 miles each; Texas, 50 miles; and Minnesota and New Hampshire as yet undetermined mileages. In addition, requisitions for material have been made by the highway departments of New York, Illinois, Nevada, North Dakota, Massachusetts, Tennessee, Georgia, Mississippi, Rhode Island, and other states.

For the curing of concrete, the mats are made from two pieces of a cotton fabric, known to the trade as "Osnaburg," and an interposed batting of raw cotton, or some form of cotton waste. Mats of standard size are 22½ feet long and 75 inches wide. The filler is 69 inches wide and is stitched between the covers with the outside edges flush on one side, thus providing a 6-inch-wide flap on the other side that is made up of the two thicknesses of the cover material. Such mats are designed for curing roads 20 feet wide. There is, accordingly, an overhang of 15 inches on each side; and it is specified that the 6-inch flap of each mat shall be overlain by the filled edge of the



THE MOHAWK TRAIL

A hairpin turn on a famous road near North Adams, Mass., which follows closely the route of the original pathway traveled by the Indians. The native Americans left countless trails that are now largely incorporated in our highway system.

succeeding one. The mats are spread as soon as possible over the fresh concrete surfaces. They are wetted thoroughly before being placed, and are kept wet until the curing is completed. The minimum period of application specified is 72 hours.

Various materials are now used for the curing of concrete roads. The most common of these is unquestionably straw, which is put on wet and is watered at regular intervals. The purpose of the covering is to protect the concrete from the sun and to promote slow, gradual curing, a procedure that lessens the likelihood of cracking. Cocoa matting and white-rubber sheeting have also been employed, and calcium chloride has been suggested because it will absorb moisture from the air and keep the surface wet. An earth blanket is sometimes used, likewise a waterproofed paper strengthened with rope fiber or other material to prolong its life. Special curing blankets of felt and bituminous preparations are on the market for the same work.

Probably the most extensive experimental program in connection with roads is that now being conducted along the lines of soil stabilization. As explained by C. A. Hogentogler and E. A. Willis, engineers in the division of tests of the Bureau of Public Roads, "Soils are unstable when the force required to displace them laterally exceeds their shear strength. Sliding of the soil particles follows. Failures of fills caused by slips, penetration of subgrade soil into the interstices of porous base courses, and the rutting of subgrades, base courses, and road surfaces are the results.

"The purpose of soil stabilization is to provide road surfaces with enough abrasive resistance and shear strength to accommodate traffic under prevalent weather conditions, without detrimental deformation. There are two general methods for accomplishing this: 1—By providing the soil with coarse and fine materials of the proportions and character required to produce stability, and possibly supplementing this by adding chemical admixtures to maintain the stability thus produced. 2—By incorporating water-insoluble binders in fine-grained or poorly graded soils, consolidating in a particular manner to provide structural stability, and covering the bases thus produced with thin wearing courses to provide resistance to abrasion.

"In either case, the stability that can be obtained depends upon (1) the physical characteristics of the soil particles, (2) the cohesiveness of the binder, and (3) the strength and permanency of the joint that can be developed between soil particles and binder."

As far back as Roman times, it was discovered that remarkably fine roads could be built by putting down successive layers of soils from different hillsides and valleys. Government soil specialists now know the principles behind soil behaviour and how to test and to classify natural materials and to combine them in the correct proportions so as to assure stability.

In some instances it is necessary to add calcium chloride, or some other moisture-retaining chemical, to give soil binders sufficient moisture to facilitate compacting of the graded mixtures by traffic. In other cases it is desirable to use water-insoluble binders such as portland cement and bituminous materials to provide films that are more substantial than those of water alone.

Roads of this kind are known variously as calcium chloride-gravel roads, stabilized gravel-type roads, calcium-gravel roads, and by other similar names. If they are constructed correctly, they will not become muddy, slippery, nor rutty in wet weather; will not ravel nor become dusty in dry weather; and can be maintained smooth and firm and well-nigh free from loose material under all weather conditions. Natural materials for making them can be found in nearly all sections of the country. Stabilized roads to be satisfactory require adequate drainage of the subgrade.

Experimental work is also being carried on in connection with other phases of highway construction. Cork is now being used as a filler for expansion joints in concrete roads. The cork particles are bound together with a phenol-formaldehyde type of resin—the material having all the resiliency of regular cork and, in addition, all the chemical permanence of a synthetic resin. It fits tightly against the concrete slabs at all times and prevents the entrance of water and of other foreign matter. For many years, expansion-joint fillers consisted almost exclusively of premolded or poured asphalt. Near El Paso, Tex., cottonseed hulls are being successfully employed in cross joints to prevent the asphalt filler from swelling up during hot weather. First a layer of asphalt is poured into each joint, and then the hulls are added.

Regardless of the type of road being built, careful supervision is today the rule. Nothing is left to chance. Laboratories have been established in virtually every state, and all materials—whether they be cement, sand, gravel, asphalt, tar, reinforcing steel, paint, or something else—are subjected to minute and detailed investigation to make sure that they are up to the standards specified. Before bids are asked for, a great amount of preliminary engineering is done. Great care is given to the matter of securing the best alignment, and extensive surveys are conducted. Oftentimes aerial observation and photography are resorted to in establishing a line. Once the general route is determined, samples of the soil are taken at various points and tested to ascertain the character of the subgrade. The geological and geographical conditions are studied so that the highway engineers will know what to expect during construction and after the road is in place. If the information so obtained indicates that the route is not satisfactory, a better one is sought before contracts are let. After the concrete has been laid, samples of it are taken with core drills and examined and tested to determine whether the pavement is of the prescribed thickness and strength.

As a result of the advance made in roadbuilding during recent years, roadbuilding machinery has undergone marked modernization. Trucks, tractors, shovels, graders, rollers, portable compressors, rock drills, mixers—in fact all contractors' equipment has been improved to the point where good roads can be built with economy and efficiency.

This is the second of two articles on highway construction, by Mr. Powell.

The "Queen Mary" Goes Into Service

WITH all the majesty befitting a vessel of her name, the *Queen Mary*, latest of the superliners, glided into New York Harbor on June 1 at the completion of her first Atlantic crossing. As was the case during her sea trials, the great ship met her guarantees in every respect, and elicited the statement from her owners, the Cunard White Star Line, that they were entirely satisfied with her performance. No effort was made to exceed the existing time record for the crossing; but a top speed was attained that augurs well for success in the event that an attempt shall be made to gain the coveted blue ribbon that the *Normandie* of the French Line now holds.

The *Queen Mary* is in every sense a floating palace; but she was built to make money, and her splendor was a secondary consideration. Her builders and owners emphasize that, despite her fine appointments, she is still essentially a ship, sturdily constructed to withstand greater stresses and strains than she is ever likely to encounter, and equipped with the most modern appliances for safety and safe navigation.

The *Queen Mary* is 1,018 feet long overall, 1,004 feet long at the water line, 118 feet wide, and 135 feet high from keel to top of superstructure. Her gross tonnage is 80,773, and her maximum draft is 40 feet. Accommodations are provided for 735 passengers in the cabin class, 760 in the tourist class, 580 in the third class—a total of 2,075—and for a crew of approximately 1,200.

The cabin-class and tourist-class restaurants are air conditioned, and the temperature in all staterooms can be regulated as the occupants choose. More than 30 British artists made the paintings and other works of art which are features of the public rooms. The ship contains more than 50 varieties of wood, many unusual ones, as well as rare stones, having been used for finishing purposes.

The engines provide approximately 200,000 hp. Twenty-four water-tube, oil-fired boilers generate steam at 400 pounds pressure and 700°F. temperature to operate four sets of turbines, each of which consists of four units. Power is transmitted by gearing to four propeller shafts. There is bunker capacity for 6,300 tons of fuel oil, and the supply can be replenished in eight hours. Aside from propulsion, the ship is all-electric.

The *Queen Mary* was started as *No. 534* in December, 1930. Work was suspended in December, 1931, and resumed in April 1934. She was launched and christened on September 26, 1934. Approximately 10,000,000 rivets were driven in the course of her construction.

NEARING HER DOCK IN NEW YORK

The *Queen Mary* shown against a background of skyscrapers on lower Manhattan Island as she passed up the Hudson River on June 1 at the termination of her maiden voyage across the Atlantic. The vessel will maintain regular fortnightly service between New York, Southampton, and Cherbourg. The picture is a reproduction of an aerial photograph by Aerial Explorations, Inc.

Speed Marks Reopening of Vital Rail Link

Lawrence A. Luther

A FIRE of undetermined origin, burning as though on forced draft through a 19-foot flue, destroyed, on the night of Sunday, May 24, 1936, the sturdy timbering of Tunnel No. 8 on the Southern Pacific Company's main San Francisco-to-Portland line. This tunnel is 21 miles south of Dunsmuir, Calif.; and being south of Black Butte—the junction point from which the Cascade and Siskiyou lines diverge northward—its burning interrupted through service on both these routes and necessitated diverting all through freight and passenger trains via Donner Pass and Reno across the Sierra and north through Klamath Falls over the Modoc freight line.

The tunnel was 345 feet long, with a curvature of 10°. It penetrated, at a maximum depth of 185 feet to top of rail, one of the shoulders of rock forming the western wall of the sinuous Sacramento River canyon. By the morning of May 25, caving of loose rock had effectually closed its portals; and heat, fumes, and the uncertain condition of the overlying rock made immediate reopening of the bore impracticable. A "shoo fly" or temporary detour on a 15° curvature was promptly decided upon by Messrs. J. H. Dyer, vice president in charge of operation, and A. T. Mercier, general manager, consulting on the job with engineering officials who had motored to the location during the night of May 24.

Since every cubic yard of rock moved would bring the work that much nearer completion, a 240-cfm. single-stage compressor stored in a CCC camp was secured to operate such drilling equipment as was available at Dunsmuir; a 2-cubic-yard Link-belt crawler-mounted shovel was transported 60 miles to begin operations at the north end; and an American Gopher with a capacity of 1 cubic yard was brought 150 miles and unloaded at the south end. Through the coöperation of the U. S. Forestry officials, permission to use the CCC camp barracks for billeting temporary workers was granted, while regular Southern Pacific labor and bridge and building gangs were housed in camp cars. Peak employment figures showed a total of 230 men engaged on the job, 210 of these being regular employees.

At 6:00 a.m. on Tuesday, May 26, two 315-cfm., 2-stage, Type 40 compressors arrived by stub train from San Francisco, and were unloaded at car-door level on tie cribs. A 6-inch air line had already been constructed about 200 feet and, reduced to 4 inches, carried 150 feet up the cliff by a water-service gang using rope tackle. From that point a special 3-inch line of light, quick-coupled pipe, which had been delivered with the compressors, was assembled along the irregular face of the canyon to serve all drills. One-and-one-half inch lines of standard pipe equipped with manifolds and valves were run down to connect with the ¾-inch hose lines from the drills. Expert welders on the job made the manifolds and special connections required. A locomotive whistle was installed to blow warnings before blasting and as a resume-work signal.

The two compressors were connected to the 6-inch line with special 2-inch hose and were fueled and started as soon as they were unloaded. Maintaining a line pressure ranging from 100 to 110 pounds, they were kept on 24-hour service. Twelve S-49 "Jackhamers" and a complete assortment of 1-inch hexagon "Jackbit" rods in 2-foot changes up to 20 feet arrived with the compressors. A complete assortment of center and side-hole "Jackbits" was also provided, and an air-driven "Jackbit" grinder was set up on May 27, cooling water for it being elevated some 30 feet from the river by an air-driven pump. Their drilling precision and resistance to wear, and the facility with which they can be used, made the detachable bits invaluable in quickly organizing and maintaining good drill per-

PANORAMA OF OPERATIONS

A view from high up on the opposite wall of Sacramento Canyon, showing power shovels, tractors, and other equipment concentrating on the job of building a new track around the projecting nose of rock through which the line formerly ran. The arrows point to the portals of the tunnel which was put out of commission by fire in the timbering and by subsequent caving.

AT THE SOUTH END

This picture, taken the day after the tunnel was rendered useless, shows how quickly work was begun on cutting a new line around the knob of rock. The two portable compressors in the foreground were sent from San Francisco and at once began to supply air for the rock drills.

formance on this touch-and-go job. The stock of drill steel required was materially lessened, conventional sharpening equipment was dispensed with, and marked economy resulted.

Forty and 60 per cent dynamite was used with electric exploders; and drilling and loading of holes was in charge of qualified men regularly employed by the railway. Three shifts were worked; and drilling was done by three gangs, one drilling 20-foot down holes from the top of the slope where little earth overburden interfered with operations. The rock near the surface was heavily stratified and considerably shattered; but extremely hard diorite was encountered at elevations ranging from 10 to 30 feet above grade line.

Excavation was held to grade on track location as work advanced from both ends toward the center; but the area between the track location and the river remained somewhat above grade. For four days six power shovels, with an aggregate bucket capacity of 8¼ cubic yards, were busy at the toe of the slope. Shovels were rented and rushed to the job, as follows: Through the Butte Tractor & Equipment Company, a 1½-cubic-yard Northwest owned by Larsen Brothers, Sacramento, and a 1-cubic-yard Lorain owned by Clarence Young, Chico, while a 1½-cubic-yard P&H was obtained directly from The George Pollock Company, Sacramento. Four caterpillar tractors—two RD7's, one RD8, and one 75—all equipped with Le Tourneau angledozers, were rented from the Butte Tractor & Equipment Company and were serviced by that company.

The "cats" were employed to waste spoil over the river bank and to widen fill for realignment of the old track to connect with the ends of the new section. Perhaps a precedent was set in the amount of mechanical equipment that was mobilized hastily and that worked effectively in a small area. Booms and dipper sticks made a massed attack on muck piles after each shot, while drilling and loading operations were being pushed at other points.

Track construction was in charge of W. F. Monahan, general track inspector, and was advanced from both ends as fast as excavating was completed to line and grade. An American locomotive ditcher served on the north end to finish grade and to place rails. Slag and volcanic cinder held near by under load were dumped to surface new and realigned track. An estimated 25,000 cubic yards of rock had been handled when, at 5:19 p.m. on Sunday, May 31, the southbound Cascade Limited swung around the curve and officially reopened the line.

Rehabilitation was in charge of W. H. Kirkbride, chief engineer, who was represented in the field by Messrs. E. E. Mayo, assistant chief engineer; P. T. Robinson, engineer of maintenance of way; G. W. Rear, engineer of bridges; W. F. Monahan, general track inspector; H. Pollard, general fire inspector; and R. B. Chapman, supervisor of work equipment. A. T. Mercier, general manager, was on the job throughout the work, as were Messrs. W. L. Hack, superintendent, and J. A. Given, district engineer, representing the division. Quick reopening of the line was not effected without much careful planning and supervision; and during the critical stages of the work certain of the aforementioned officials remained at the scene of activities for as long as 48 hours without rest.

LAYING TRACK

As this view shows, the rail-laying gangs followed at the heels of the excavators. In the foreground are two S-49 "Jackhamers" drilling the final rounds to bring the roadbed to grade. The track was extended around the hillside from both ends, the crews meeting near the center.

Problems of Compressor Stations in the Dust Bowl

THE trials and tribulations of operators of compressor stations situated in the dust-storm areas of our Southwest were strikingly brought out in a paper presented at a recent meeting of the American Gas Association at Dallas, Tex., by R. T. Powers of the Texoma Natural Gas Company, Fritch, Tex. Within the Dust Bowl, as it has come to be known, lies the panhandle of Texas and of Oklahoma, western Kansas, southeastern Colorado, northeastern New Mexico, and a section of southwestern Nebraska, a region extending about 400 miles north and south and 300 miles east and west. There the prevailing high winds reach their peak in the spring of each year, carrying with them swirling clouds of impalpably fine dust which it is almost impossible to exclude from the plants.

"There have been numerous occasions," says *Gas*, "when operators in compressor buildings could barely see from one end of an engine to the other even with all available lights burning, and many operators can remember one or more occasions when they could do no more than grope uncertainly around the engines in an almost impenetrable darkness. On unnumbered occasions dust settled in a few hours to a depth of 1/64 inch to 1/32 inch over exposed portions of engines, on foundations and on floors. Due to breathing action the dust entered crankcases, mixing with the bearing oil, completely overloading oil filtering systems, mixing with the oil and being pumped to bearings with harmful effect. One station reported a 2-inch accumulation of mud in crankcases in a few days with a maximum of .104-inch wear on the babbitt of crosshead shoes in five days' time, the oil feeling like grinding compound.

"Bearings ran very hot, dust entered lubricating oil supply tanks, oil measures, grease cans and lubricators unless very careful precautions were observed. Valve motions, cams and cam rollers wore to an unusual degree. The windings of open type electric generators and motors became completely clogged with dirt.

"Practically all companies have fastened well-fitting canvas covers over the tail guides and openings in the intermediate crosshead guides of the engines, and these covers have proved reasonably effective although a tendency to vibrate and breathe allows some dust to enter the guides.

"Externally, the dust storms damaged or destroyed paint, ruined automobiles and trucks in a single season, covered up lawns with layers of dust one inch to three inches deep, buried stored equipment, filled up gate and drip boxes, half submerged property line fences and seriously contaminated cooling water systems."

Aside from the usual precautions, such as sodding the ground for a considerable distance around the compressor stations, some companies have calked the lap joints in the corrugated outer covering and the joints between the covering and the flashing and the door and window frames. Others have soldered the longitudinal joints of the corrugated-iron sheathing and have filled the lesser joints with strips of oiled felt and the larger spaces with a combination of calking compound and asbestos fiber moistened with oil. These efforts, at best, are but a makeshift.

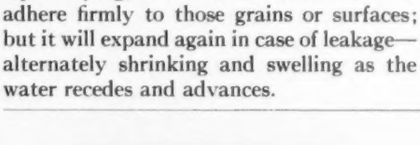
In all likelihood, new stations in the region will be constructed with the dust problem in view, and the chances are that they will be air conditioned so that they will at all times be effectually sealed.

Grouting with Bentonite to Prevent Seepage

BECAUSE of its inherent property to swell when brought in contact with water, bentonite, a bedded plastic clay, is being used to advantage in preventing water seepage. According to a recent issue of *Mineral Trade Notes*, bentonite such as is found in the Black Hills of Wyoming and South Dakota is especially suitable for pressure grouting of this kind because it will absorb nearly five times its weight in water and may increase as much as fifteen times in volume. If a slurry of about 6 or 8 per cent bentonite in water is forced by compressed air into a permeable sand or gravel bed, or into rock, the mineral will coat the grains or surfaces, fill the voids, and make the formation impervious to water, even when it is under high pressure. Upon drying, the bentonite will shrink and adhere firmly to those grains or surfaces; but it will expand again in case of leakage—alternately shrinking and swelling as the water recedes and advances.

It has been suggested that seepage around or through dams may be stopped by drilling holes to the permeable zone and by pressure grouting with bentonite; that it might serve in the form of a mud fluid to seal the walls of oil wells against leakage; and that it might be employed to reduce or to check the flow of water into open pits or quarries where the overburden or surface rock is pervious—the slurry in the latter case being introduced through a series of holes circling the excavation. It is authoritatively stated that the U. S. Forest Service and other interests, both private and public, are successfully holding water at bay in this way. Hitherto the mineral has been used principally in the manufacture of paints, fertilizers, paper and the like, in the refining of crude oil, as a filler in phonograph records, textiles, etc., and in the making of such pharmaceutical preparations as "Denver Mud" and antiphlogistine.

Floyd Huntington



FLOYD HUNTINGTON, one of the best-known rock tunnelmen in the western part of the country, died at Colfax, Calif., May 21, following an illness of several weeks. He was 50 years old.

Mr. Huntington was considered one of the foremost authorities on tunnel-driving methods and technique, and he had been identified with many large undertakings in this country and South America. He learned drilling in the Northwest, and went from there in 1921 to the Southern California Edison Company's developments in California. Later he worked on tunnels and dams for the San Joaquin Light & Power Company in the same state.

In 1926 Mr. Huntington became a salesman of drilling equipment for Ingersoll-Rand Company, but left that position about two years later to direct a tunneling project in Colombia, South America. Returning to the United States, he once more became a salesman, but again he remained at that work but temporarily. When Six Companies Inc. obtained the contract for building Boulder Dam in 1931, they engaged him as superintendent in charge of driving the four 56-foot diversion tunnels through the walls of Black Canyon. On that job he made an enviable record in speed and effectiveness of drilling. From the Boulder Dam he went with the Walsh Construction Company as superintendent in charge of that concern's tunnels on the Metropolitan Aqueduct from the Colorado River to Los Angeles. He was working there when taken ill.

Mr. Huntington is survived by his wife; a daughter, Jean; a son, Seldon; a sister, Mrs. J. A. Gally; and two brothers, Lester and W. A. Huntington, both of whom are identified with tunneling operations on the Metropolitan Aqueduct.

MEXICO'S NEW HIGHWAY

AFTER numerous unforeseen construction delays, occasioned by the ruggedness of the country it traverses, the highway leading from the United States boundary to Mexico City was opened on July 1. Known as the Camino Nacional No. 1, it is the first long modern highway in Mexico. It is the initial unit in the 4-road arterial system planned in 1925 by Plutarco Elias Calles, then president of the republic, and forms an extension of U. S. Highway 81, which connects Dallas and San Antonio, Tex., and proceeds southward to Laredo, on the Rio Grande. It is an essential link in the projected international highway from Alaska to Buenos Aires.

More than $17,000,000 has been spent in building this 770-mile roadway, or an average of more than $22,000 a mile. The engineering and construction methods employed conformed with the best prevailing practices elsewhere, and a considerable proportion of the expenditures made went for the purchase of modern mechanical equipment in the United States. Salvador Toscano, premier highway engineer of Mexico, directed the work and, at times, accomplished the seemingly impossible in transporting huge bridge girders to remote locations and in erecting them across precipitous canyons. More than 80 bridges were built.

Much of the route is through mountainous country, and its elevation varies from 600 to 8,300 feet. In many places a shelf had to be blasted out of steep cliffs. The final stretch, not far from Mexico City, proved the most difficult, and one 600-yard section had to be rebuilt many times because rock slides swept it away with discouraging regularity. The road has been constructed with easily negotiable grades, is well protected by guard rails, and is of 2-car width throughout. Even so, its serpentine course demands great vigilance on the part of drivers. As a scenic route, it is claimed to rank with the world's finest.

Great significance was attached to the opening of the highway, as it was held to be a harbinger of closer relations between the United States and Mexico. It is a well-established fact that nomadic American motorists will go wherever good roads lead them, and it is believed that thousands of them will annually visit the republic to the south of us. The journey by car to Mexico City has hitherto been more of a hair-raising adventure than a pleasure trip.

One shortcoming at the present time is the scarcity of adequate accommodations *en route* for travelers, but steps are being taken to remedy this. Such cities as Monterrey, Linares, Victoria, and Valles afford adequate facilities. The government is constructing three modern tourist camps near Valles, and numerous private camps are being built at other points.

Meanwhile, construction of the road is being continued southward to Acapulca. It was from this Pacific Ocean port that Hernando de Alarcon set sail in 1540 on the historic voyage that led to the discovery of the Colorado River, thus starting the chain of events that recently culminated in the erection of Boulder Dam. When the Spanish explorer fared forth in his tiny ships, his course was uncharted and dangers lurked everywhere. Coincident with his departure, Coronado headed a land expedition that proceeded northward in search of the fabled Seven Cities of Cibola. Two of his men eventually reached the Colorado; but Alarcon had been there and had left. Coronado's trip was marked by hardships, and required many weeks to make. By using the new road, the same journey can now be made comfortably in four or five days.

The opening of the highway was marked by an exchange of greetings and expressions of amity between high officials of the United States and the Mexican governments. Vice President Garner, whose home at Uvalde, Tex., is only a few miles from the point where the new road starts, headed the delegation from this country. It so happened that the dedication took place just about 400 years after the first white man crossed the Rio Grande River from the north and found his way to Mexico City after a wearisome journey of many months. That trail blazer was Alvar de Vaca, who set out on his long trek from Florida.

TENNESSEE UNDER CONTROL

THROUGH the gracious coöperation of Mother Nature, the Tennessee Valley Authority has been able to put its scheme for controlling the flow of the Tennessee River into operation sooner than was expected. The aid came in the form of heavy rains, which filled the reservoir back of Norris Dam on the Clinch River more than two months ahead of the estimated date. As a consequence, it was possible to begin releasing some of the stored water on June 19 instead of on September 1, as scheduled.

As has been explained in descriptive articles published in this Magazine, Norris and other high-level reservoirs will be drawn upon during the low-water period to increase the flow of the Tennessee and thereby to augment the generation of power and to deepen the channel for navigation purposes. With only Norris Dam contributing storage water, it will be feasible, TVA engineers state, to maintain the main-river flow at 15,000 second-feet at Florence, Ala., just below Wheeler Dam. When other dams on the headwaters are in place and functioning, the flow of the Tennessee will be kept at an effective stage regardless of the season of the year.

Norris Dam, a 1,000,000-cubic-yard concrete structure, was started in October, 1933, and its sluiceway gates were closed on March 4 of this year. By the end of this summer, its two 56,000-kw. generators will be ready to operate. Thus, in a span of less than three years, all the objectives of this $36,000,000 undertaking will have been attained. Aside from conserving valuable water, the dam greatly lessened the flood in the main river during the period of heavy rainfall and thereby prevented considerable property damage.

Industrial Notes

Fishermen, especially, will rejoice to learn that a Swedish inventor has succeeded in making a match that is waterproof.

According to a German engineer, the tensile strength and adhesive power of sprayed metal are increased if the metal object which is to receive it is heated before the first coat is applied.

For the convenience of the foundry executive, the Pangborn Corporation, Hagerstown, Md., has published an illustrated quick-reference catalogue covering its entire line of blast-cleaning and dust-collecting equipment. A copy may be obtained free of charge upon request.

To facilitate communication with Chosen and Manchukuo and to speed up local east-and-west railway traffic, Japan is contemplating the construction of a subaqueous tunnel linking the important islands of Honshu and Kyushu by way of Shimonoseki and Moji.

Under the trade name of Creata Solvent, the Creative Chemical Company is marketing a liquid for softening boiler-feed water. It is said to be free from soda ash, to neutralize acid contamination, to prevent pitting, and not to carry over into the steam nor to cause foaming. It is introduced at the suction end of the feed pump.

A new plant for electrolytically coating steel wire with zinc has been put in operation at Johnstown, Pa., by the Bethlehem Steel Company. The process in use there is also new, and is termed Bethanizing. A coat of any thickness may be deposited; and the wire is said to have remarkable mechanical properties.

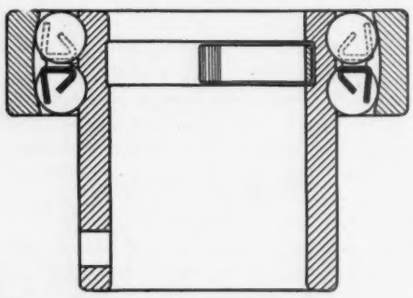
Pitch that will not slide in hot weather nor crack when the temperature is low is recommended by The Barrett Company for roofs that have a slope of from 2 to 6 inches per foot. Used in combination with gravel or slag this coal-tar compound makes a fireproof covering. The new product is known as Steep-Roof Pitch.

Protectakote is the trade name of a new material for coating the inner surfaces of tanks used for the storage of petroleum products. It is claimed to be inert to benzine, naphtha, gasoline, and kerosene; to be proof against cracking, chipping, flaking, or peeling; and to protect the bottoms of the tanks from the corrosive action of the water that collects there.

To prevent gold-bearing silt from flowing down the tributaries of the Sacramento River and thence into San Francisco Bay, four hydraulic mining dams are to be built by the United States Government at a cost of $6,945,000 on the Yuba, Bear, and American rivers. This region, it has been estimated, contains 604,000,000 cubic yards of workable gravel, or sufficient for twenty years of hydraulicking.

At one of the newer broad-strip-steel mills, the cooling of the product as it passes from the roughing to the finishing trains is effected by jets of compressed air without a halt in its progress. The general practice is to spray the strip with water, or to let the atmosphere do the work while it is temporarily brought to rest on what is termed the delay table.

A grip-lock bearing is the latest addition to the SKF line of ball and roller bearings numbering more than 1,200 sizes and types. It is the conventional SKF self-aligning extended inner-race bearing with an eccentric groove machined in the bore of the inner race. Fitted in that groove is a piece of spring steel with knurled ends. This is known as the grip-lock shoe, and when it is in the deepest part of the groove the bearing can be slipped on the shaft and then



locked by holding the inner race while the shaft is turning in the direction of operation, the knurling gripping the shaft and causing the shoe to wedge in the shallow part of the eccentric groove. No tools and no shaft-machining are required to apply the new bearings; and, according to the manufacturer, "the greater the load, the tighter the grip locks."

Parchment paper is being made in England by a new method, according to the London correspondent of *Chemical & Metallurgical Engineering*. It is a development of the Igraf process and depends for its effectiveness upon vacuum, under which the stock is impregnated with chemicals containing gluten and keratin. The product is suitable for bookbinding, and can also be used to advantage in the making of wall coverings, plywood, Celotex, etc. It is waterproof and, when polished, virtually unscratchable.

Technical Coatings, Inc., New York, N. Y., has announced a new line of metal coatings the base of which consists of vegetable gums and heat-treated oils. The resultant films are claimed to be nonporous —airtight and watertight—elastic, and proof against corrosive atmospheric gases. Finishing materials in standard colors, including a high-gloss acid-resisting gray, are available, together with primers for various purposes. Pure turpentine or high-grade mineral spirits are used as thinners; and application is made by brush, air spray, or by dipping.

A network of pipe lines for the transportation of coal from the sources of supply to the points of use was pictured recently by John D. Battle, executive secretary of the National Coal Association. Experiments to this end have been made, he announced, and the results obtained lead to the belief that the day will come when coal will be carried underground like gasoline and for maximum distances of 200 miles. The coal would be "ground as fine as talcum powder" at the mine and forced through 8- to 10-inch piping with water under pressure, booster stations being placed along the line at intervals. Upon reaching its destination, the coal would be dried and burned in powdered form in special furnaces.

How great a dependence is placed upon steel in the United States is brought out by statistics recently published by the American Iron and Steel Institute. The figures are based on production and consumption since 1865, when the Bessemer process was introduced. The calculations show that the quantity of steel used by every man, woman, and child in this country increased from 2,600 pounds in 1900 to 15,940 pounds in 1930. After that the demand dropped, reaching 15,890 pounds per capita at the end of 1932 during which year the output failed to keep pace with an increase in population of more than 750,000. Today, the figure stands at 16,800 pounds, or a total tonnage of 954,000,000.

Cellophane has made it possible, according to the Du Pont Cellophane Company, to bring about a long-sought-after improvement in the design of electric motors. It is being used to insulate the wire, with the result that the required "turns" of copper take up less space than heretofore. The material can be had in a thickness considerably less than one-thousandth of an inch and in ribbons ranging in width from 1/32 to 1/4 inch. These can be wrapped around the wire with mathematical accuracy thousands of times a minute by means of insulating machines. A special adhesive assures a permanent bond, and a lacquer finish completes the job. Aside from saving space, actual motor performance has shown that Cellophane has a higher resistance to excessive temperatures than have other insulating materials and that its use results in a quicker dissipation of the heat generated in the windings.